THE ECONOMICS OF COTTON IN THE SUDAN WITH SPECIAL REFERENCE TO THE SUDAN GEZIRA SCHEME

BY

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Abstract

Sudan, as many of the developing countries producing agricultural primary commodities, is faced with the problem of inadequate and unstable export proceeds. Despite the growing disagreement on the causes and the consequences of this phenomena, it has been shown that for Sudan this is due to her concentration and export of one cash crop, extra long staple (ELS) cotton.

This study, therefore, is an inquiry into the aspects governing the economics of ELS cotton production and marketing in Sudan and is based on empirical analysis.

It needs emphasizing, however, that the accuracy of the estimates and the conclusiveness of the results are largely determined by the quality of data and the computational procedures applied. To this effect, the data available whether in details or length of the time series, is not adequately commensurate with the degree of sophistication implied in the type of regression analysis attempted. For example, the size of the sample is sometimes smaller than what would warrant adherence to the conventional significance test at 5% level. The results are, therefore, accepted in relative terms and should be interpreted in context of those constraints.

The study is divided into seven chapters. Chapters 1-3 constitute an introductory part; the problem, position of agricultural sector and pattern of land use and a description of the institutional organization of the cotton sector (symbolized by the Gezira scheme) which in addition to its unique experience it is believed to have some effects on the analysis attempted.

Chapters 4-6 is an empirical analysis of the basic relationships of demand, supply and pricing policy of Sudan ELS cotton.

Chapter 7 is a summary and discussion of the results obtained and their implications on cotton policy decisions.

Broadly speaking, the results suggest that in view of the inelastic world demand for ELS cotton and growing competition from man-made fibres, Sudan must adjust her cotton production policy to the long-term prospects of demand. Diversification with other enterprises and processing activities should be encouraged. As has been suggested by the results obtained from supply and production function analysis, increased use of fertilizers and pesticides would favourably effect ELS cotton output and yields. More important is the need to reconsider the institutional set-up of the cotton sector so as to accommodate more incentives for the tenants while the large scale of the producing schemes must be preserved. Tenants are believed to respond positively to increasing incomes by putting more effort.

On the other hand Sudan cotton in the individual export markets studied (U.K., France, Germany, F.R., Italy and India) appeared to have relatively high price elasticity as well as high cross price elasticity with the similar variety of Egypt. Despite these signs of keen competition and the fact that Egypt is the largest ELS cotton producer, Sudan, during the period of study seemed to have set her ELS cotton prices in a way that did not approximate to the assumptions of the oligopolistic market as postulated by economic theory for similar market situations. As Sudan cannot afford to delay the disposal of her crop without experiencing serious adverse effects, it is believed that it is to the interest of both countries (Egypt and Sudan) to adopt some sort of a co-ordinated ELS cotton policy.

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Chapter One

Introduction

One of the major problems facing the developing countries, given their diverse absorptive capacities, is the shortage of foreign exchange. This sets limits to the import capacity of a developing country in financing its requirements of capital goods and technical skills in the course of its economic development.

The problem manifests itself in two ways: a declining long-term trend of prices impedes a rapid rate of growth, while the short-term (year-to-year) fluctuation introduces a great deal of uncertainty in the working of the economy and does not permit the governments of such countries to take a long-term view of things. There is, however, no unanimity of views on the role, causes, consequences and remedies of this foreign exchange constraint.(1) There is, perhaps, more agreement on the causes of the long-term aspect of the problem than on what causes it in the short-run. Yet, it is in the short-run that most of the policy issues and concern lie and most of the disagreements arise.

The declining long-term trend of prices of primary commodities is generally attributed to increasing output of these commodities, inelastic demand with respect to both price and income, competition with synthetic and technological improvements which reduced the raw material contents of these commodities in the final processed product. On the other hand, short term, year-to-year, fluctuations

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(1) Broadly speaking, the controversy could be divided between "trade-economists" and "development-economists". This is, sometimes, labelled in the literature as "monetarists" versus "structuralists". (a) J. Pineus, Trade, Aid and Development, 1967, Chap. 4, p. 117-143; (b) W. Baer & I. Kerstenetzky, eds., Inflation & Growth in Latin America, 1964; (c) Aboyade, O. "Trade, Capital Distortion & Planned Development", African Primary Products & International Trade, 1965, Stewart, I. (ed.); (d) H. Johnson, The World Economy at the Crossroads, 1965, p. 73-76; (e) A. McBean, Export Instability & Economic Development, 1966.

in prices and/or proceeds of exports are usually explained as follows: most of the developing countries, who face inadequate and unstable export proceeds, specialize in production of primary commodities which are characterized by low demand and supply elasticities. This low elasticity of both the demand and the supply makes the response to price changes rather weak. On the supply side, unlike the case with manufactured goods, production involves time lags and is subject to random exogenous factors e.g. weather. In many instances, production of such primary commodities is a way of life and with meagre alternative employment opportunities, the supply response becomes more inflexible.

The specialization in production of primary commodities is sometimes coupled with concentration on one or two products. Production is export-based which means heavy reliance on foreign trade and external markets. With these markets stagnating and the low price and income elasticity of demand, the consequences for the developing countries become grave.

The instability of export earnings, its causes and consequences, has attracted a lot of concern in recent years. A number of studies have been made by U.N. agencies as well as individual researchers, the most recent and comprehensive being McBean's.(1) On the basis of an extensive survey of the literature and a number of case studies he suggests that:

> "Such theoretically proposed general factors as specialization in primary products or commodity concentration <u>per se</u> may have some slight systematic tendency to produce export instability, but their explanatory value in particular cases is very small. Even in broad discussions of why underdeveloped countries' exports should be more unstable than rich countries' exports, they are not particularly helpful. ... we are not even sure whether short-term fluctuations in export proceeds does harm to the less developed nations. ... From the

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(1) McBean, A., <u>Export Instability & Economic Development</u>, 1966.

> analysis here and the published results of Coppock, Massell and Michaely it seems clear that statistical evidence on instability yields little, if any, support for policies of diversification or industrialization as means of avoiding fluctuations."(1)

Apart from the case studies which were limited to five countries (Uganda, Tanganyika, Pakistan, Chile and Puerto Rico), his conclusions are based mainly on a highly aggregative cross-country study. This applies also to the studies of Coppock, Massell and Michaely.

Developing countries, as McBean himself admits, are too heterogenous to be grouped together for fitting cross-country regressions and the results need to be verified by far more detailed case studies of individual countries before any generalizations can be made. Such individual case studies, each focusing on the characteristics of the respective country and its export products, would provide a profound base for policy decisions arising in these countries. The practical importance of more detailed case studies is believed to be more revealing in view of the fact that the developing countries, faced with the foreign exchange problem (shortage and instability), have kept on increasing the output of their traditional exports. In doing so these countries make a hard choice. And although this may be justifiable in the context of their objective of increasing and/or stabilizing export earnings in the short run, yet such a policy may itself be self-defeating in the long run, depending of course on the conditions of both supply and demand of the export product and the factor endowment of the developing country in question. It is in this context that the present study was conducted.

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(1) McBean, A., Export Instability & Economic Development, p. 56.

Sudan presents a picture of a typical developing economy, cotton being its major export crop. It accounted, on the average, for more than 60% of total value of export proceeds during 1953-65. This, undoubtedly, reflects a high degree of commodity concentration and any endeavour to analyse the causes of her export instability or for that matter the whole economy has to be focused primarily on this single commodity.(1) In the face of insignificant domestic cotton(2) consumption, and a complete dependence on foreign demand, it seems likely that Sudan's economy would be influenced by any fluctuations in cotton exports' earnings.

Table (1.1) illustrates the significance of foreign trade (exports plus imports) as well as cotton exports in the total gross domestic product and that part of it [G.D.P.] generated in the non-subsistence sector (money sector).

Table 1.1. Percentage of foreign trade and cotton in G.D.P. (total) and G.D.P. (money sector).

	1955	1960	1965
F. Trade/G.D.P.	35	36	27.2
F. Trade/G.D.P. (money sector)	80	75.8	62
Cotton exports/G.D.P.	10.6	9.3	6
Cotton exports/G.D.P. (money sector)	24.6	20	14

Source: Calculated from data reported in various issues of Economic Survey, Ministry of Finance & Economics, Khartoum, Sudan.

Cotton export proceeds recorded a higher instability index (24%) than total export proceeds (16.8%) over the same period,

(1) Seers, D., "An approach to short period analysis of primary producing countries", O.E.P., 1959, p. 6-9, 27.

(2) The study is confined to extra long staple (ELS) cotton which constitutes about 98% of Sudan cotton production. The whole crop is for export as the recently established textile mills so far consume only short staple of the American type.

1950-1965.[1] Compared with those of Uganda, Tanganyika and Pakistan in McBean's study, Sudan's cotton export instability index seems to be considerably higher. This is shown in the following table:

Table 1.2. Instability indices for the major export proceeds of Sudan, Pakistan, Uganda, Tanganyika and Nigeria. 1948 - 1960.

Country	Cotton		Jute		Coffee		Sisal		Cocoa		Palm Kernel	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Sudan	26.9	26.9										
Pakistan	26.7	15.4	19.4	14.2								
Uganda	19.7	14.6			20.9	14.7						
Tanganyika							19.6	19.5				
Nigeria									18.3	16.1	12.7	9.8

(a) Av. percent change U.N. Method.

(b) % deviation from 5 years moving average centred on the middle year.

Source: Sudan: Calculated from data in Ec. Survey, various issues.

Uganda, Tanganyika, Pakistan: McBean, 1966, tables, (5.4, 5.5), (6.1) and (9.8) respectively.

Nigeria: From G. Helleiner (table 3), Peasant Agric. - The Nigerian Case, African Primary Products and International Trade, (1947-1962), 1965, edited by Stewart, I.G.

The countries in table (1.2) with which Sudan is compared are considered to have more unstable export proceeds than the average underdeveloped country. Though instability indices in table (1.2) are given for the individual export crops, these crops are the major components in each country's total exports. It is therefore reasonable to use them as an approximation for instability in total export proceeds. One can easily see that Sudan is relatively more exposed to sharp short-term fluctuations in her export earnings. It is also evident that fluctuation in export earnings was moderate in countries having more than one major item of export. It may be

(1) Index of instability is calculated by the U.N. method which always divides by the higher figure for each pair of years. (Instability in Export Markets of Underdeveloped Countries, U.N. 1952), p. 79, App. B.

that some of these countries e.g. Uganda and Nigeria, operate stabilization schemes which would mitigate the direct manifestation of the market conditions of their respective export commodities; a situation which Sudan's cotton exports do not experience. This is one of the adverse effects which would be imparted to any generalizations based on grouping heterogenous cases into a cross-country study. In view of this and the relatively low export instability in countries with more than one export item, it might be difficult to accept McBean's conclusion that commodity concentration is not a very important factor leading to instability in export earnings.(1)

The fluctuations of Sudan's export proceeds are accentuated by the absence of other crops which could effectively reduce the fluctuations in cotton export proceeds, and by the fact that cotton production itself is subject to sharp variations. During 1950-1965 cotton yields recorded an instability index of 27% (using U.N. method of dividing the change by the higher of the two year figures). Cotton yield variability in Sudan is relatively very high when compared with its counterparts for other countries producing the same variety of Sudan's cotton; extra long staple.

Using the coefficient of variation(2) as a rough measure of instability, Sudan cotton yields turned out to have the highest estimate of fluctuations of the four important producing countries; U.A.R., U.S.A. and Peru as is shown in the following table.

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(1) McBean, A., Export Instability & Ec. Dev., 1966, p. 50-57.

(2) Coefficient of variation $= \frac{\text{standard deviation}}{\text{mean}} \times 100.$

Table 1.3. Instability indices of the ELS cotton yields per acre (coeff. of variation %)

1954 - 1962

U.S.A.	8
Peru	19
U.A.R.	21
Sudan	31

Source: IBRD Report on Extra-long Staple Cotton, 1964, p. 34.

Despite this high coefficient of variation of cotton yields, ELS cotton area has been expanding in Sudan.(1) This deliberate policy of expanding the acreage under cotton, with a view to increasing or at least maintaining the export earnings, has in fact made the country more vulnerable to short-term fluctuations.

On the demand side, and with Sudan's total reliance on export markets, year-to-year fluctuations in volume reinforce the adverse effect of the long-term movement of export prices and proceeds. In pursuit of the objective set at the beginning of this chapter; easing the shortage of foreign exchange and maintaining it at current levels, Sudan approximates to the typical developing economy which makes the hard choice of expanding production of her traditional exports. In Sudan's case, receipts of foreign exchange would rise less than the rise in total output as the price elasticity of aggregate world demand for extra long staple cotton is less than unity.(2)

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(1) The following figures reflect the magnitude of ELS acreage expansion between 1950 - 1965:

	1950/51	1955/56	1965/66
In 000's irrigated feddans*	256	369.7	748
In % of 1950/51 figure	(100)	(144.5)	(292)

* feddan = 1.038 acre.

(2) This is a result obtained and shown in chapter IV of the present study where more vigorous analysis is attempted for ELS cotton demand.

Having examined the case for Sudan's export instability, let us now consider its consequences on the Sudanese economy.

In order to assess the impact of such fluctuations, one has to analyse the relation between them and the main indicators in the economy (e.g. G.D.P., investment, producers' income, imports, etc.). The instability indices for these various economic indicators, presented in table (1.4), broadly suggest that there is some relationship between fluctuations in export earnings and the fluctuations in these indicators (directional). But when regression analysis was used, no statistically significant results were obtained.

Table 1.4. Instability indices of Sudan economic indicators.

Ec. Indicator	Instability Index % *	Period
G.D.P. (total)	5.2	1955/56-1965/66
G.D.P. (money sector)	7.6	"
G.F. Investment	15.9	"
Total Imports	14.8	1950 - 1965
Imports of capital goods and equipment	25.2	"
Producers' income +	44.9	1950/51 - 1963/64

* Av. percentage annual deviations calculated according to U.N. method of dividing by the higher figure of the two years. (Details of these series are given in table (1), App. (D).)

+ It represents the Gezira scheme's tenants' profit share of cotton proceeds.

Source: Various issues of Sudan Ec. Survey, IMF financial statistics and Gezira Board statements of accounts.

Though this may give support to McBean's conclusions which are based on similar insignificant relationships, one tends to question the quality, the detail or length of the series, of the data used. Such qualifications would not be out of place in the context of developing countries' statistics of which Sudan is no exception.

However, most important to our discussion, is the influence of cotton exports fluctuations on the process of capital accumulation and producers' incomes. The reason for singling these out is their importance within the course of economic development of the country. Stability of export proceeds helps the country to undertake the investment programme in a more orderly and planned manner. On the other hand, the stability of producers' incomes is of special importance in the context of Sudan's cotton production organizations. According to this institutional set-up, cotton growers i.e. tenants in public or private schemes, are not in a position to substitute between cotton and other enterprises. Almost all inputs, except the effort they put into cotton, are fixed to them.(1) In these circumstances, the effort they are willing to put in is believed to be influenced by the reward (income) they get from cotton production. This hypothesis is tested in chapter V when an attempt is made to measure Sudan ELS cotton supply response.

Referring back to table (1.4), one would notice that investment and producers' income (tenants' profit share) have both shown a fairly high index of instability. The tenants' income shown in the table refers only to Gezira tenants, yet the result could fairly be extended to tenants' income in the rest of the cotton sector. Gezira alone contributes more than 50% of cotton production in the country. So unstability creates difficulties and hardships and with the declining trend of profits acts as a disincentive for more effort and willingness to grow cotton.

(1) More account of the institutional set-up is given in chapter III of this study.

What is more significant with regard to capital formation is the instability index of the imports of capital goods and building materials. This shows the direct connection between cotton foreign exchange earnings and the part they finance of gross fixed investment. This part has an index of instability of 25.2% higher than its counterpart of total imports, 14.8%. Sudan could only guard against the adverse effects of cotton export fluctuations by use of her accumulated foreign reserves and securing an inflow of external finance. To this effect, finance of gross fixed investment relied on domestic savings between 1955/56 - 1960/61,[1] while between 1960/61 - 1965/66 both reserves and external sources played a significant part in financing investment's import requirements which the execution of the ten-year plan needed. Table 1.5 illustrates this situation.

Table 1.5. Finance of Gross Fixed Investment 1960/61-1965/66

(Million Sudanese Pounds)

Year	Domestic Savings	External Finance	Total Investment
1960/1	36.8	7.0	43.8
1961	39.9	22.7	62.6
1962	56.9	8.6	65.5
1963	51.7	29.3	81.0
1964	39.3	12.4	51.7
1965	34.7	10.3	45

Index of foreign reserves 1960/61 = 100

1960/1	1961/1962	1962/1963	1963/1964	1964/1965	1965/1966
100	91.7	86.6	59.9	42.6	35.8

Source: Ec. Survey various issues, IMF financial stats. Dec. 1966 (supplement).

(1) Ministry of Finance, Government of Sudan, Ten Year Plan for Ec. Dev. 1960/61 - 1970/71, p. 16.

Both external finance and accumulated reserves helped to keep the level of imports beyond the actual import capacity as determined by total export proceeds. The level of both investment and consumption of imported goods has been maintained at higher levels. This is more obvious in the case of total imports which fluctuated less than capital goods imports.

Another variable which is influenced by cotton export instability is the public revenue and expenditure. This is due to the direct participation of the government in cotton schemes, and to the structure of the government revenue which depends mainly on import duties.(1) The latter is a function of export proceeds if we assume away the existence of adequate foreign reserves and foreign capital. However, the receipts from this source help to moderate the fluctuations as they are collected with a time lag.

Another phenomenon, mentioned by McBean in the context of other countries, has some relevance here. He feels that the dominance of expatriate(2) firms in the export sector in such countries results in a relative stability of export earnings. Since such firms have abundant financial resources, they can plan their inventory policy in a way which cushions year to year fluctuations. In the absence of expatriate firms this cushion is not available to Sudan, and therefore susceptibility of public revenue to export fluctuations is considerably increased. Most of the cotton stocks are held with the schemes producing cotton, mainly Gezira, and there is little tendency for exporters to

(1) Share of import duties and government participation in cotton schemes amounted to 37% and 12% of total govt. revenue, on average, between 1960/61 - 1965/66.

(2) McBean, A., Export instability & Ec. Dev., 1966, p. 86-87.

accumulate big stocks at their end. This tendency is reinforced by the competitive nature of the auction system (followed in selling Sudan cotton) which does not encourage exporters to hold stocks.

Thus it seems reasonable to assume that instability of export earnings has hampered sustained economic development of the country. Reasons for such fluctuations lie both in demand and supply forces as well as policy measures adopted by the government and the Gezira Board, the major cotton producing sector. Hence in the present exercise attention is focussed on some of these problems.

The study is based on empirical analysis and is divided into seven chapters. Chapters II and III serve as a background to the study. The former shows the position of the agric. sector in the economy, the pattern of land use and factor endowments. The latter describes the institutional organizations of the cotton sector which is believed to have some influence on the analysis attempted.

Chapter IV investigates the international demand for Sudan ELS cotton. This covers five of the main export markets (U.K., France, Germany F.R., Italy and India). Its competitiveness with other producers and with synthetic fibres is analysed. Derivation of the respective demand functions is based on time series between 1953 and 1965.

Chapter V is devoted to the study of the supply side. This covers two basic relationships: supply relations and production relations. Because of data availability and its special position, more emphasis is given to the Gezira scheme. The period of study was therefore taken as a whole period 1945 - 1964 and a sub-period, 1950 - 1964.

Chapter VI deals with the pricing of Sudan ELS cotton; the mechanism of its determination and testing the underlying hypothesis of the adopted policies in the context of economic theory. The latter suggests an oligopolistic market, a hypothesis which will be treated empirically from observed price series between 1953 and 1965.

Chapter VII is a discussion and summary of the results empirically obtained and the conclusions that would emanate out of them for practical policy-making.

Chapter Two

Position of Agriculture and Pattern of Land Use

Modernizing agriculture is an immense process of social and economic change. The intermingling aspects concealed under growth and development have therefore led to various theories and points of view in the extensive literature accumulating on the subject. There is no one possible synthesis to which all agree. Yet the fact remains that development would take place when better utilization is made of the available resources. To Sudan this means that, as all the evidence suggests, agriculture is the priority sector of the economy for promoting social and economic development.

The total area of the country is 2,506,800 sq. kilom., with a population of 12,650,000 in 1962/63. Sudan is endowed with land and water but with no mineral deposits of significance so far. The country's resource base, therefore, limits the possibility of a heavy industrial development.(1) The dominance of the economy by the agricultural sector will continue at least in the foreseeable future.

I Position of Agriculture.

At present agric. accounts for more than half of the G.D.P. and provides employment for 86% of the labour force. Its relative importance is illustrated by the following table.

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(1) At this point it seems useful to define the meaning of industrialization. The concept has been mostly taken to refer to manufacturing activities. However, in context of development economics the concept could be more thorough and revealing if taken as "an economy-wide phenomenon, applying to agriculture and to service trades as well as to manufacturing; the essence of it is not the products typically considered as "industrial" but the rational approach to the production process itself that it embodies." See H.G. Johnson, Economic policies towards less developed countries, 1967, p. 45, 46-52.

Table 2.1 Composition of G.D.P. by Economic Sector

<table>
<tr><th>Sector</th><th>1955/56</th><th>1960/61</th><th>Projected for 1970/71, end of Plan period</th></tr>
<tr><td></td><td>%</td><td>%</td><td>%</td></tr>
<tr><td>(a) Agric., livestock, forestry & fishing</td><td>61</td><td>57</td><td>51</td></tr>
<tr><td>(b) Transport, Distribution & banking</td><td>14</td><td>15</td><td>14</td></tr>
<tr><td>(c) Mining, manufact. & P. utilities</td><td>1</td><td>2</td><td rowspan="2">16</td></tr>
<tr><td>(d) Building & Construction</td><td>6</td><td>7</td></tr>
<tr><td>(e) Drafts, Domestic & misc. services, ownership of buildings</td><td>12</td><td>11</td><td rowspan="2">19</td></tr>
<tr><td>(f) Admin. & social services</td><td>6</td><td>8</td></tr>
<tr><td>Whole economy</td><td>100</td><td>100</td><td>100</td></tr>
</table>

Source: Sudan's Ten Years Dev. Plan 1961/62 - 1970/71, p. 13, 45. Ministry of Fin. & Ec., Khartoum.

The dual structure (modern and traditional) of the agriculture sector is far more obvious in Sudan than many other developing economies. The modern sector uses fairly advanced agricultural techniques and practices and grows primary cash crops (with food crops for those who are engaged in it) mainly for exports. The traditional or subsistence sector is, as one would expect, much less attached to the market economy. Among the factors responsible for the dominance of this structure are inadequate transport and irregular availability of water.

II Pattern of land use

Out of the vast land area of Sudan (619 million feddan) only about 3% is under cultivation. The distribution of Sudan's arable land among the different uses is as follows:

Table 2.2. Pattern of land use in Sudan

Use	feddan (000's)	% of total
Cultivated land	17,500	2.8
Potentially productive land	98,800	16
Forests	226,000	36.5
Pasture & Meadows	59,000	9.6
Waste land & others	217,400	35.1
	618,700	100.0

Source: Table (1) of Mr. El Saeed paper, p.68. Conference papers on agric. development in Sudan, (ed.) J. Shaw 1966, Khartoum.

The table exhibits, assuming that it is economical, the enormous potential yet to be developed in the agric. sector.

The total area cultivated is divided among the crops produced in the country as well as by method of irrigation followed in growing these crops. Table (2.3) and (2.4) hereafter illustrate this situation:

(i) According to method of irrigation

Table 2.3. Total Cultivated Area of Main Crops By Types of irrigation (in %)

Type	1953/54	1958/59	1963/64
Irrigation	10	14.7	16.7
Rain	86	83	82.2
Flood	4	3	1.6
Total	100	100	100

Source: Calculated from data in Bulletin of Agric. Statis., Ministry of Agric. 1964.

The expansion in the irrigated areas is explained by the emergence of private cotton schemes as well as the Managil extension of the Gezira scheme during the period 1953 - 1964. Expansion of irrigated areas depends upon investments in dams and canals while in the rain-fed areas it mainly depends on projects to supply water for drinking in the dry season. The irrigated area however recorded an increase of more than 40% between 1953/54 and 1963/64.

This reflects the fact that the development of Sudan's agric. sector is limited by the availability of adequate capital. Rapid development could not be achieved without a sizeable package of investment.

(ii) According to crops

As most of the rain-fed land is cultivated within the subsistence sector, most of the crops grown are food grains and oilseed. These crops are mainly grown for their own consumption. The inadequacy of the transport system and storage is, however, influencing the distribution of food crops and creating malfunctioning of their markets.

The main crop dominating the irrigated areas is ELS cotton. Because of its special importance, the percentage of the total irrigated areas under cotton is given below (for other crops see table (3) App. D).

Table 2.4. Areas under irrigated cotton as % of total artificially irrigated areas

1953/54	1958/59	1963/64
61.6	60	70.5

Source: Calculated from Bulletin of Agric. Stats. 1964.

The percentages show the position cotton occupied. This means that cotton has taken the major part of the investment and development effort in the past. At least in the foreseeable future, cotton will remain the backbone of the Sudanese economy.

To sum up, this brief review showed the following: that the position of agric. sector in the economy and factor endowment make Sudan's economic development depend on what could be achieved within this sector. That development of Sudan's agric. needs a sizable investment. And most of the past investment and development within the agric. sector was devoted to cotton production. In view of the big potential yet to be developed and the scarcity of the capital needed for further development effort, an important aspect of the development policy is to make the optimum use of the resources already employed in the agric. sector.

Chapter Three

The Institutional Organization of Cotton Sector

As cotton is the major agricultural product, which influences considerably the growth of the economy, exports and employment,[1] it needs some special attention. In addition it has an enviable record of experimenting with a new organizational structure, the successes and failures of which may provide some guidelines for agricultural development in other developing countries. This chapter describes this organizational structure and its possible effects on the analyses attempted later.

The cotton sector of Sudan can be distinctly divided into public and private sectors. The public sector comprises schemes where the government shares the proceeds with tenants and a managing board. The Gezira scheme is the biggest unit of this sector. Public sector cotton accounts for more than 65% of Sudan's irrigated cotton productions (Table 3.1 below).

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(1) a. Between 1955 and 1961, the modern sector, of which cotton is the major component, was responsible for the growth of the economy (4.7% per annum). This was the average of the growth rates experienced in the two sector of the economy: Modern sector (6.7%) and subsistence sector (3%).

b. Both lint and cotton seeds accounted for more than 60%, on average, of total export value (1953-1964).

c. 20% of Sudan population live in the central region (i.e. cotton belt) where 90% of irrigated cotton is grown. For example the Gezira scheme alone provides the livelihood for 75,000 full support and 400,000 seasonal jobs.

Table 3.1 Distribution of Area and Production of ELS Cotton Between Public and Private Schemes 1945-1966

	AREA (%)				
Type of scheme	1945/46	1950/51	1955/56	1960/61	1965/66
Public schemes					
(a) Gezira	66.2	55.1	59.9	63.1	68.4
(b) Others	29.1	38.6	13.6	7.9	3.7
Private schemes	4.7	6.3	26.5	29.0	27.9
Total	100	100	100	100	100
	PRODUCTION (%)				
Type of scheme	1945/46	1950/51	1955/56	1960/61	1965/66
Public schemes					
(a) Gezira	75.2	76.0	64.3	54.6	65.7
(b) Others	20.8	15.6	7.6	5.2	4.0
Private schemes	4	8.4	28.1	40.2	30.3
Total	100	100	100	100	100

Source Bulletin of Agricultural Statistics, Ministry of Agriculture, Khartoum, 1963/64 and 1964/65.

The private sector on the other hand is a significant part of the cotton sector. Most of the private sector consists of pump schemes brought into business under the stimulus of the Korean War boom in the early 1950's. Their share in area and production is given in table(3.1) above.

The Gezira is the major scheme(1) where cotton was first produced in commercial quantities in Sudan in 1925. With the exception of the Gash and Tokar schemes (flood irrigation), all the other cotton schemes whether public or private, emerged

(1) The scheme covers an area of 1,800,000 feddans (feddan = 1.038 acres).

at later dates and adopted the organizational set-up, agricultural practices and the rest of the experience evolved and accumulated in the Gezira scheme. The study of the instutition of the cotton sector would therefore be approximated by that of Gezira in the discussion.

I. Organizational structure of Gezira scheme

The Gezira scheme organization stands as a unique experience of agricultural development during the last 50 years. As it stands now, the scheme is a tripartite partnership between the government, tenants and a managing board. The board is subject to government direction and control. It took over the management of the scheme in 1950 when the private foreign company's concession came to an end after 25 years. This has been the only major change that has taken place since the inception of the scheme in 1925.

The partnership agreement regulates the duties and rights of each partner, the government provides the land and water, the tenant provides all the labour needed for the agricultural operations of cotton production and finally the management board assumes the responsibilities previously shouldered by the private foreign company. These include the management of the scheme, provisions of finance[1] and marketing of the crop.

(a) The Government:

It was agreed that the government would provide the land and water needed for the scheme. This involved the acquisition

(1) The board's working capital is borrowed from the government (Ls. 4 million at 6% rate of interest).

of the land by renting it from the original owners (compulsorily if necessary) and construction of a dam (Sennar) together with the canals and ancillary networks for the flow of water over the scheme's area.

The government, aware of the bitter experience and results that followed development of irrigation in Egypt,[1] tried to prevent these undesirable social effects and unequal distribution of wealth in Sudan as a consequence of the Sennar dam construction. To prevent the effects of the rising value of land accompanying the development scheme of Gezira, all the area needed for the scheme was registered for the original owners. After that the land was rented at a pre-development rent of 2 shillings per feddon for 40 years. In other words the land value fluctuations and increases were suppressed for 40 years. Moreover the right of ownership transfer or sale of this land was controlled by making it necessary to contact the government before any action was taken. This resulted in 65% of the scheme's area being government owned land, a factor that ensured the continuity of the scheme beyond the 40 years' initial contract.

The scheme's land was then divided into standardized[2] tenancies (small family holdings). All who were living in the scheme's area were given equal right to apply for these tenancies irrespective of being an original land owner or not.

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(1) Gaitskell, A. Gezira: A Story of Development, 1959, p.289, See also Jogaratnam, T. "Plantations Agriculture and Economic Development" International Explorations of Agricultural Economics P.102. R.N. Dixey (ed.) 1964.

(2) Tenancy size is 40 feddons for Gezira main scheme and 15 feddons in the Managil extensions. With eight course and six course relations respectively the size of a cotton holding becomes 10 feddon in Gezira and 5 feddon in Managil.

(b) The management of the scheme

The Sudan Gezira Board is at present the managing body that took over from the private foreign company which undertook the responsibility after the establishment of the scheme in 1925 up to the end of its concession in 1950. However, the Gezira Board followed suit and adopted all the practices and policies evolved by the company during its concession period in administering the scheme.

One basic difference between the company and the board is that the former acted fully as the entrepreneur and the decision-making authority while the board, though an autonomous body, is subject to government directions and policies.

The Company provided the working capital to operate the scheme after the government had fulfilled its obligations by preparing the land and water required. The main stages in the company's duties were:

(1) Offering loans (credit advances) to tenants during the crop year according to the work performed and phased out on the various agricultural operations of the cotton crop from pre-sowing until handing over the harvest to the management. These advances were made against a condition embodied in the tenancy regulations for handing over the cotton crop yield to the management of the scheme. It is illegal to dispose of it in any other way.

(2) Management of the scheme and in particular the field operations. This field management is of particular interest. It brought the tenants under the supervision of the field inspectors (see attached sketch). This supervision extended to almost all the operations of the cotton crop and the standard of the work undertaken.

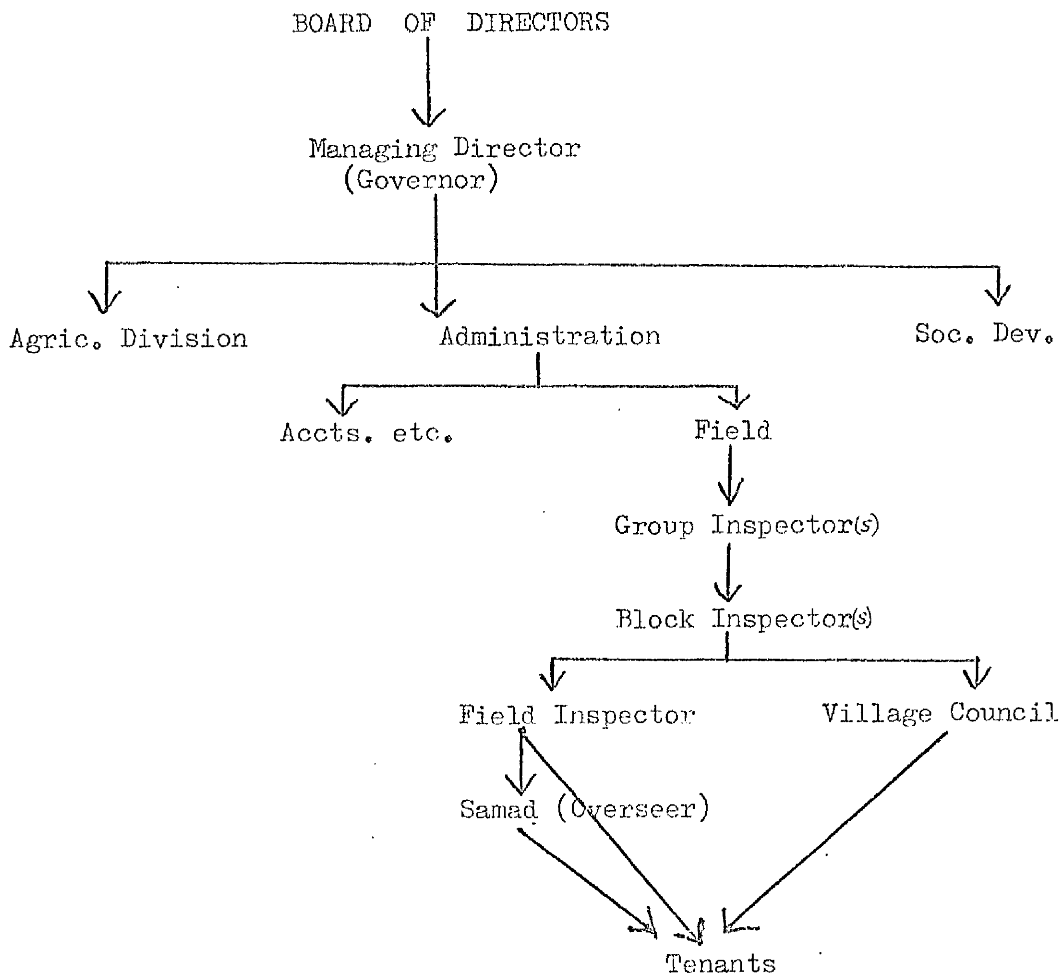
(3) Marketing of the cotton crop. This entailed the necessary network required for preparing the cotton in a saleable shape (i.e. ginning, grading, baling, transport, storing etc.).

(c) Tenants

The tenancy system as applied in Gezira was really adopted as an alternative and a modification to the system of hired labour. This was learnt from the first private estate (Ziedab) approved to produce cotton in Sudan before the Gezira scheme. It showed that the plantation model which was contemplated does not suit the local conditions and attitudes of the people. Accordingly the tenancy (crop-sharing) became the basis of the production units and the labour required was to be drawn from the family and those whom the tenant hires when necessary.

The bulk of the tenant population were sowing these lands with the aid of rain before artificial irrigation was introduced with the Gezira scheme. This together with the introduction of cotton as the purpose rotation crop in the Gezira scheme made the management more inclined to follow a very close and

Sketch of the Administrative
Machinery of the Gezira Scheme



strict field supervision. The tenants, therefore, were left deprived of all initiative in connection with the cotton crop and had merely to undertake the work required as instructed. All the rotation, area allotment, other inputs, even labour, which is their responsibility, were determined by the central management of the scheme. Besides cotton, there are two other crops which provide food (Dura) and fodder (Lubia) requirements. For these no supervision or credits are given and they accrue entirely to the tenants. Tenants are under the direct supervision of field inspectors assisted by locally appointed persons (Samad) and village councils.

(d) Sharing the Proceeds

The formula adopted for the sharing ofproceeds by Gezira authorities was based on the usual practice of the tenants society when they entered into joint agricultural production activity before the scheme.[1] However, the percentage shares have been changing over the years.

During the private company's concession (1925-1950), 35% of net proceeds of cotton sales went to the government, 25% to the private foreign company managing the scheme and financing it and 40% to the tenants. By 1950 when the scheme was nationalized the distributive shares were altered to 42% to government, 42% to tenants, 10% to the new managing agency, the Sudan Gezira Board (S.G.B.). The balance (6%) was allotted as 2% to tenants Reserve fund, 2% for local government councils, in the irrigated area and 2% for Social Services in the scheme.

(1) For interesting details and a comparison with Russian Kolkhoz see: "Gezira and Russian Kolkhoz" by Versluys, J.D.N., Economic Development and Cultural Change, 1953 (April, June and October, 3 parts).

Another two readjustments were made with the result of raising the tenants' share against a reduction at the government's. In 1964 these new shares were 40% for the government and 44% for the tenants while in 1965 they became 34% and 50% respectively.

Originally the picking labour requirements were the tenant's liability as he is required to provide all necessary work for the cotton crop, but now it is chargeable against the joint collective account(1) of expenses (other than labour) incurred during the season and until the cotton is marketed. This account is the only deductable item from gross proceeds of cotton sales before it is subject to distribution. The inclusion of picking labour costs in this joint account together with increasing their share to 50% illustrates the dissatisfaction of the tenants with the income they derive from cotton production and the pressure they exert on the government.

Beside the purpose crop cotton, the rotation includes two other crops, Dura (Sorghum) and Lubia (fodder). These two crops accrue to the tenants and they pay no charges for the land and water used as is the case with cotton. The advantages of this rotational system are believed to be:-

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(1) Joint account includes:

- crop production expenses: fertilizers, pesticides, sowing seeds, weeding, pulling out cotton roots
- Seed cotton expenses: cotton sacks, handling and transport to ginning
- Ginning and baling
- Transport, marketing, storage expenses for lint and cotton seeds
- crop insurance
- depreciation provisions for fixed assets used.

(i) It provides the tenants with an assured food crop (Dura) previously grown on uncertain rainlands.

(ii) Cash crop which helps to generate money income.

(iii) The rotation meets the agronomic aspects of soil conservation and fertility as the two crops (Dura and Lubia) are legumes needed to counteract the exhaustive effects of cotton.

The tenants share of gross proceeds is credited to the tenants' collective account. On the other hand, advances made during the crop year, cost of mechanized operations undertaken by the board on behalf of the tenants and picking expenses, are debited to their joint collective account. Two important facts underlie this arrangement: firstly it worked as a guarantee for the company and later the managing board to charge these items of loans and expenses collectively to the tenants with the condition that they should handle the whole cotton crop once it was picked. Secondly, these costs are jointly and collectively borne by the tenants (i.e. indiscriminately) while their share of cotton proceeds is distributed proportionately according to what each produces in his tenancy and hands over to the management against a receipt showing the volume.

In sum, the institutional set-up of the Gezira scheme is essentially a "combination of individual enterprise with large scale efficiency involving compulsion in rotation, seeds, fertilizers use, marketing..."(1)

(1) Lewis, W.A. The Theory of Economic Growth, P. 135. See also Lord Hailey An African Survey 1956 (rev. ed.) P.1011-1014.

II Private Pump Schemes

This is purely the private sector in the cotton industry of Sudan. Although these schemes broadly follow the practices and organizational aspects of Gezira scheme yet there are some points of difference as follows:

(1) These schemes are based on partnership between the licencee and the tenants of the scheme. The licencee assumes all the duties undertaken by the government of the board in the Gezira scheme. He provides the land, water, all the irrigational network, finance required for both fixed and operational expenses, administration and marketing of the crop. They (licencees) mainly rely on commercial banks and the agric. bank for the finance these schemes require.

(2) Accordingly the distributive shares are different. The licencee gets all the remainder after paying the tenant's share of 42% of cotton proceeds up to 1964 and 44% afterwards. Tenants grow their food crops - in Gezira with no charges or sharing. moreover, no reserve fund deductions are made. From his share, the licencee pays 5% land tax together with the usual business profit tax.

III Marketing Policies

For the purpose of studying the marketing policies of Sudan cotton it is necessary to distinguish between the public schemes' cotton where the Government is a partner and the privately produced cotton in private estates. The reason for this is that the marketing policies adopted were mainly designed for disposing of the public sector cotton (i.e. Gezira and other schemes).

However, a brief review of cotton marketing development in Sudan can be discussed under two headings: bulk sale and auction system.

(a) <u>Bulk Sale</u>:

Broadly speaking, this policy was the major arrangement through which Sudan cotton was marketed since it was produced on a large scale in the country (1925) and up to 1952/53 marketing year.

There were three distinct phases of bulk sale arrangement during the period it prevailed as the policy of cotton marketing. These were as follows:

(i) Up to 1940 all Sudan cotton used to be consigned to the selling agent at Liverpool. This was the British Cotton Growers Association (B.C.G.A.) which conducted the selling of the crop.

(ii) In 1940 and with the World War II, the first pure bulk sale was negotiated between the newly set up British Cotton Control Commission and Gezira authorities. The Cotton Control Commission regulated cotton trade during the War.

(iii) Between 1948-52, the Royal Cotton Commission, created after the War with the aim of central purchasing and supply of raw cotton, bought Sudan cotton. This happened on a yearly renewable contract basis though the option was left to Britain of not entering into a new contract whenever she chose.

Mr. Gaitskell[1], a previous manager of the Gezira Scheme, explains that the management resorted to such an arrangement of bulk sale due to the lack of national exporters with knowledge and contacts with foreign markets and sources of international demand. Moreover this arrangement secured a continuous market for Sudan cotton.

In his review of this period, Mr. Awad[2] came out with the conclusion that Sudan's interest was not protected as Sudan cotton was marketed at lower prices than Egypt's, while the security of the market for Sudan cotton resulted in Sudan missing the chance of establishing her cotton trade in new markets. The result of concentrating her cotton trade in the British market could have been less harmful had Sudan succeeded in redirecting her cotton to growing textile centres with the recess of War reconstruction, as Egypt successfully did.

As it would appear from the ensuing analysis (ch. IV) that Sudan cotton is fiercely fighting to increase its share in the markets taken by Egypt. Such tendencies of keen competition were manifested by high cross price elasticity between the Sudanese and Egyptian ELS.

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(1) Gaitskell, A., Gezira: A story of development, 1959, Chap. 15.

(2) Awad, M.H., Sudan Cotton Marketing, Chap. II, (unpublished), M.Sc. Thesis 1965 L.S.E.

The alleged market security for Sudan cotton by bulk sale arrangement was further criticised on the way contract prices were fixed. They were fixed in the middle of the crop year rather than at the beginning in a way that did not create the guaranteed incentive from which the producer could benefit and increase his output. However, this criticism can be partly accepted while the blame is believed to be inherent in the institutional organisation of Gezira cotton scheme. It relies on the administrative element and paternalistic attitudes towards the producers or cotton growers (the tenants) in increasing output, rather than on economic incentives. Area and rotation are fixed and the tenant is required to provide his labour effort as instructed.

(b) Auction System 1952/53

An earlier success of this system for marketing Sudan cotton was hampered by the availability of supplies at Liverpool. This made cotton merchants decline from making their bids at the auctions taking place in Sudan. Moreover the existence in Alexandria (Egypt) of an active market of Sudan's type of cotton (ELS) attracted most of the cotton buyers interested in supplies of this variety.

In 1952/53 selling on the open market took place after it had been impossible to secure another bulk sale contract with the Cotton Commission as the U.K. did not renew the agreement. The first auction took place in February, 1954.

Auction sale is usually for non-standardized commodities where checking specifications is necessary. Sudan cotton is not a heterogeneous commodity; however, in the auction each grade is theoretically an independent commodity.

Actually the size of the Sudanese crop is small and does not enable or favour the establishment of a cotton exchange on the lines of those for spot and future trading elsewhere. Therefore, the adoption of an auction system was the feasible possibility when Sudan returned to free trading of her cotton.

Nevertheless, the auction system, "just like the system of future trading, attempts to centralize competition and eliminate effects of the personal influence of bargaining power of individual buyers and sellers. The means by which these aims are achieved under these two most highly competitive marketing systems are, however, different in the extreme. Whilst future contract is based on the highest possible degree of standardization of the commodity, the auction method puts the special quality characteristics of each individual lot into the foreground[1]".

The auction system as it is operated in Sudan is subject to imperfections resulting from the domestic circumstances of the whole cotton sector. This makes the mechanism of the auctions less efficient than in theory.

The size of the market is very small and the number of buyers is not very big.[2] Hence speculative movements and disturbances make the system less of a free market. Though the situation is ratified from the selling side by the monopolistic position of the Sudan Gezira Board, which is the only seller of public sector cotton at the auctions, yet (as it proved sometimes)

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(1) Blau, G. "Wool in World Economy", J.R.S.S. 1946, p. 216.

(2) Either exporters or agents on commission, i.e. the actual number attending the auctions is small.

through its inflexibility the Board's position imparts some adverse effects to cotton marketing when it fails to make rapid adjustments to buyers' actions and bids. Apparently this will result in holding cotton off sale and increasing cotton stocks. The buyers have little incentive to equalize their stocks by the very nature of the auction competitive system.

Besides, the way in which privately produced cotton is marketed adds to the imperfections of the auction system in Sudan.

(c) Private Cotton Marketing

As mentioned earlier, both the bulk sale and auction systems discussed above are confined to the marketing of public sector cotton. In fact, before the proper adoption of the auction system as a marketing arrangement for public sector cotton (1952/53), private cotton production was insignificant. It was only after the stimulus of the Korean boom 1950/51, that Sudanese private capital stepped into the business of cotton production.

Though the private cotton sector followed all the production, organizational and agricultural practice evolved in the public sector (Gezira), it departed in its marketing policy. Private cotton is disposed of between producers and exporters and is not brought to the auction. Producers who receive loans from the agricultural bank sell subject to a minimum price set by the bank. Otherwise they are free. Prices are generally less than those set by the auctions for public cotton. In a way it is some sort of permitted competition between the public and private cotton sectors of Sudan.

On the insistence of the agricultural bank, private producers have to repay their loans regularly, season by season, to the bank. Accordingly immediate sale is necessary to repay the loans and meet the pressing need for cash or new loans. For this reason the price differential is allowed.

Depending on the terms and grades of cotton the private producers offer, the public cotton will be delayed and not bought. Merchants will prefer the price difference made by the private offers. Though this arrangement may be partly tolerated in view of the agricultural banks insistence on redeeming the loans season by season, yet this is a policy instrument that can be geared to maximize the interest of all cotton producers. Moreover though private producers sometimes conclude their deals through private treaty with exporters and cotton merchant, it is widely agreed that the system of private treaty sales is not advantageous to farmers, who, acting in isolation are usually less well informed in regard to the market value of their commodities than the buying agents.

Certainly the practice followed in marketing the private cotton has its bearing on the operation of the auction system. The net result i.e. the price realized in these auctions is influenced by and at the same time influences the private cotton sales. It is only after the market is clear of any private cotton that the prices prevailing at the auctions would reflect a closer situation to pure auction outcome.

IV. The limitations set by the institutional organization of ELS cotton sector on the analysis attempted in this study

The production and marketing institutional arrangements described above are believed to have some influence on the analysis attempted in the later chapters of this study.

On the supply side of cotton, the rotation of Gezira and similar schemes imposes upon the tenants a pattern of behaviour which might make them behave differently from what is implied in the profit maximization model. Tenants are forced to grow both their food and their cash crops.(1) They therefore are more or less a consuming and producing unit. Their interest in maximizing their incomes from the cash crop, cotton, is once more jeopardized by the system of fixed sharing of proceeds. Tenants would be less inclined to increase their output since only part of the increase would accrue to them. With the introduction of other crops(2) they are willing to put more effort

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(1) The idea behind growing food crops was to ensure security of food supplies yet this proved to be successful only in bad years. See Karmek, A., The Ec. of African Dev. 1967, p. 102 and Oluwasamni, H.A., Agric. & Nigerian Ec. Dev., 1966, p. 184.

(2) Recently with permission of authorities other crops are being introduced.(e.g. groundnuts, wheat).

into these crops not subject to a sharing arrangement with much less concern for the main cotton crop. The system of close supervision and administrative control would be less effective than before.

The marketing arrangements and in particular the resulting volume of cotton stocks would adversely influence the growers' initiatives. From the statistical point of view, the relative standardization of practices and use of inputs is expected to yield higher intercorrelation among the date series used than what is normally the case with time series economic magnitude.

Chapter Four

International Demand for Sudan ELS Cotton

I. Background on Cotton Trade

Sudan relies entirely on export markets to dispose of her production of extra-long staple (ELS) cotton. This variety constitutes about 98% of total cotton produced in the country.

Unlike some other big ELS cotton producers (e.g. Egypt), Sudan has not yet developed a fine cotton textile industry. The recently established textile industry in Sudan depends mainly on the short staple variety and consumes no extra-long staple cotton. The latter is costly to use while the bulk of the domestic demand is still satisfied with the quality of cotton cloth (grey) woven from short staples. Thus the importance of the foreign export outlets needs no emphasis.

In what follows is a review of the overall demand for: all cotton varieties, extra-long staple variety and Sudan's special position. Next, an empirical estimate of the demand functions in selected export markets (U.K., France, Germany, F.R., Italy and India) is undertaken. This is believed to be more meaningful for policy decisions than attempting one aggregate estimate for Sudan's cotton in the world market.

(a) Global cotton situation (all varieties)

Among other apparel fibres, cotton consumption suffered a downward trend. This is partly explained by the increasing competition of industrial fibres in particular and competing items in consumer expenditure (consumer durables) with rising standards of living. Despite all this, cotton consumption increased in absolute terms though with a declining share as is shown in the following table:

Table 4.1. World Production and Consumption of Apparel fibres 1953 - 1962

	Period	Cotton	Wool	Rayon	Synthetics
Consumption (000's metric tons)	1953	8188 (72%)	1197 (10%)	1872 (16%)	161 (2%)
	1962	9880 (64.4%)	1511 (9.8%)	2857 (18.6%)	1080 (7.
			1952 100		
Production (index)	1953	104	101	118	123
	1962	125	127	127	835

Source: Compiled from (1) F.A.O., World Apparel Fibre Consumption (1966)

(2) F.A.O., Synthetics and their effects on Agricultural Trade, (1964).

While wool kept its relative share, cotton has been displaced by rayon and synthetics which raised their relative shares almost entirely on account of a decline in cotton consumption.

Most of this decline in cotton consumption was experienced in developed countries which reduced their imports and consumption of cotton by developing industrial fibres, with a consequent stagnation of cotton textile industries and by imposing restrictive trade barriers in face of cotton textile products from developing regions. It is in these developing countries that the potential demand lies and no decline in cotton share is anticipated.

(b) World Position of extra long staple variety

Judged by its staple length (1.3/8" and over), strength, fineness and colour, extra long staples (ELS) cotton is the best quality of cotton fibres. On the average ELS represents 5% of total world cotton production. For exports it accounted for 11.1% and 15.1% of total world cotton exports in 1953 and 1962 respectively.

As the ELS cotton variety is known for its sharp output fluctuations,[1] the percentages given before may not reflect its relative position. The following table shows the growth of area, production and productivity per acre in the four big producing countries during 1953-1964. These four countries account for more than 90% of world ELS cotton production.

Table 4.2. Area, Production and Yield of ELS cotton in U.A.R., Sudan, Peru and U.S.A.

1953 - 1962

Year	U.A.R.			Sudan			Peru			U.S.A.		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production	Area	Yield	Product
1953	895	484	907	454	384	365	134	164	46	92	340	66
1962	1255	584	1533	761	408	650	170	515	183	94	576	113

Area in 000's acre: Yield in Pounds: Production in 000's bales.

Source: IBRD Report on ELS Cotton, Table 47, 1964.

Table (4.2) reflects two facts:

(1) That Egypt (U.A.R.) is the leading producer. Sudan is the second largest producer and is at present working for a target area of one million feddan[2] to be brought under cotton by 1970.[3]

(2) Though yield per acre is not a precise measure of productivity, as land is only one dimension contributing to this measure, it is a rough indication. According to this measure Egypt ranks the first

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(1) ELS cotton variety is very susceptible to changing weather conditions, diseases and pest attacks.

(2) Feddan = 1.038 acres.

(3) Ministry of Finance, Government of Sudan, Sudan Ten Year Plan for Social and Economic Development, 1961/62 - 1970/71, p. 94.

with the highest yield per unit of land while U.S.A. ranks the second. Such a productivity comparison may be suspect as it is made for two years 1953 and 1962 only. While ELS cotton is known for its output variability and sensitivity to weather and insect conditions, the fact remains, however, that Sudan has the lowest yield per acre and its crop is subject to wide fluctuations.

As for export performance of ELS during the period of study 1953-1965, the following table summarizes the situation. The figures given represent the total exports of the three big producers who account for almost all the world exports of this commodity (Egypt, Peru, Sudan).

Table 4.3. Index of annual exports of ELS from Egypt, Sudan and Peru (1953 - 1965)

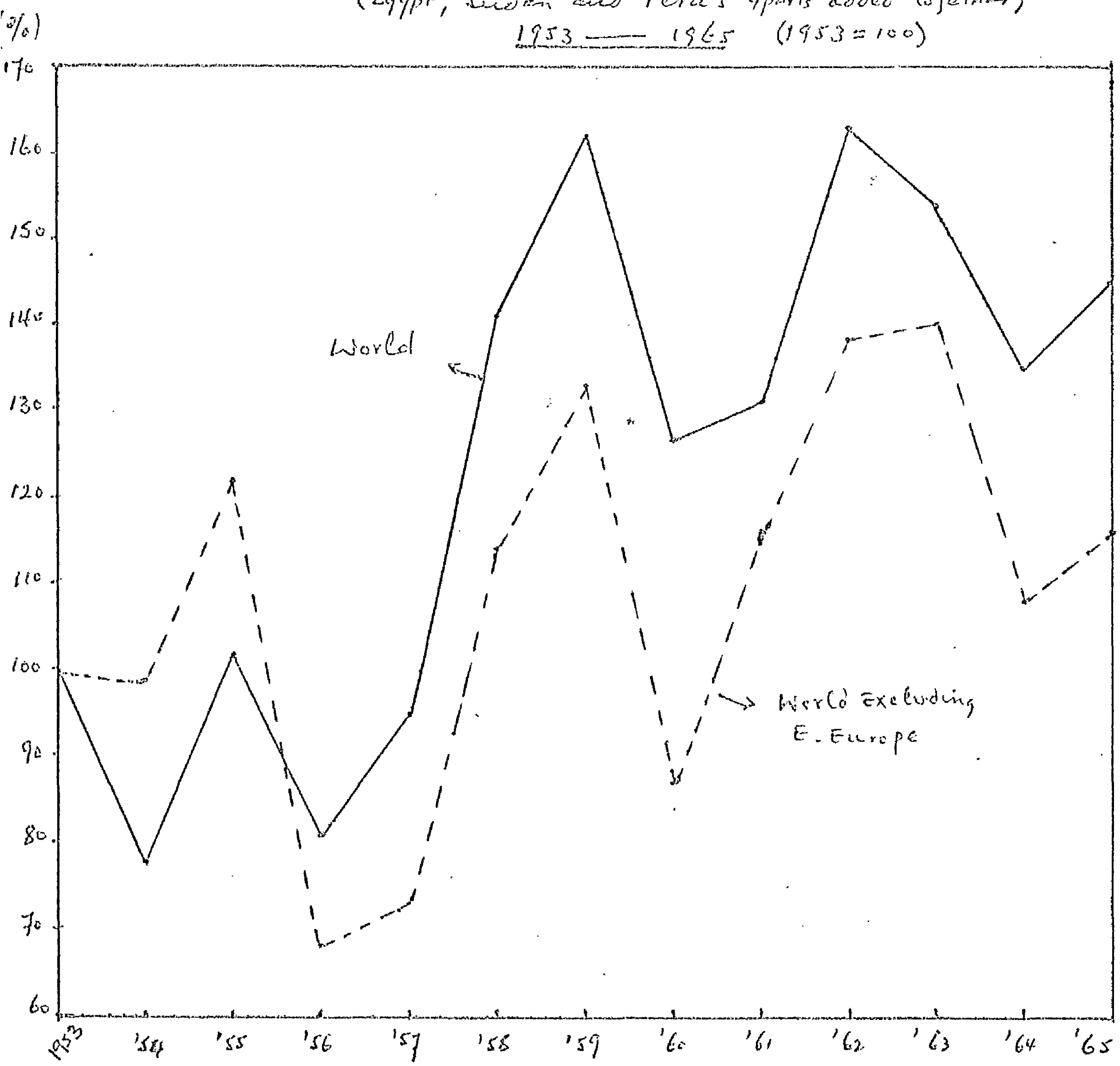
1953 = 100

Year	'54	'55	'56	'57	'58	'59	'60	'61	'62	'63	'64	'65	Average
All World	78	102	81	95	141	162	127	131	163	154	135	145	127.2
Western World i.e. (World excluding exports to Eastern Europe)	99	122	68	73	114	133	87	116	138	140	108	116	108.3

Source: I.C.A.C., April, 1959, 1963, 1966.

The breakdown of the export index into all world and world excluding exports to Eastern Europe is arbitrary. While the index of all world is compiled by adding up the exports of the three countries Egypt, Sudan and Peru, the index for the non-communist world is arrived at by subtracting Egypt's exports of ELS cotton to Eastern Europe. Due to her closer economic ties (loans, trade agreements, etc.) with Eastern Europe, Egypt consigns the greatest part of ELS cotton going to the East. Sudan exports cotton to Eastern Europe though not to the extent the Egyptians

Chart (4.1): Index of World annual exports of ELS Cotton
(Egypt, Sudan and Peru's exports added together)
1953 —— 1965 (1953 = 100)



do as Sudan stepped up her exports of ELS to these countries recently. Table (4.4) shows the percentage of exports to Eastern Europe of the total ELS exports of Egypt and Sudan 1950-65.

Table 4.4. <u>Percentage of ELS exports to Eastern Europe from Egypt and Sudan Annual Exports of ELS cotton 1950-64</u>

	1950-54	1955-59	1960-64
Egypt	26.5	48.5	59.6
Sudan	1	9.2	24.8

<u>Source</u>: I.C.A.C.

Returning to table (4.3) and accepting the definition of Western Europe and all world for the purpose of ELS export performance, one notices the following: Apart from the common year (1956) of low exports due to the Suez crisis, the growth of ELS exports to Western world has been slow. On the average for the whole period 1953-65 it recorded 108.3%, i.e. 8.3% more than what had been achieved in 1953. This index for Western Europe tends to be even lower if Sudan ELS cotton exports to Eastern Europe are subtracted as well as Egypt's.

On the other hand, the world exports of ELS have been increasing at an average of 27.2% of the 1953 figure. Most of the increase that took place is accounted for by the Eastern and centrally planned economies. As most of the transactions and consignments to these countries are concluded on terms not subject to the market forces, it is beyond the conventional analytical tools to give a precise description of the trend in direction and growth of ELS cotton exports to these countries.

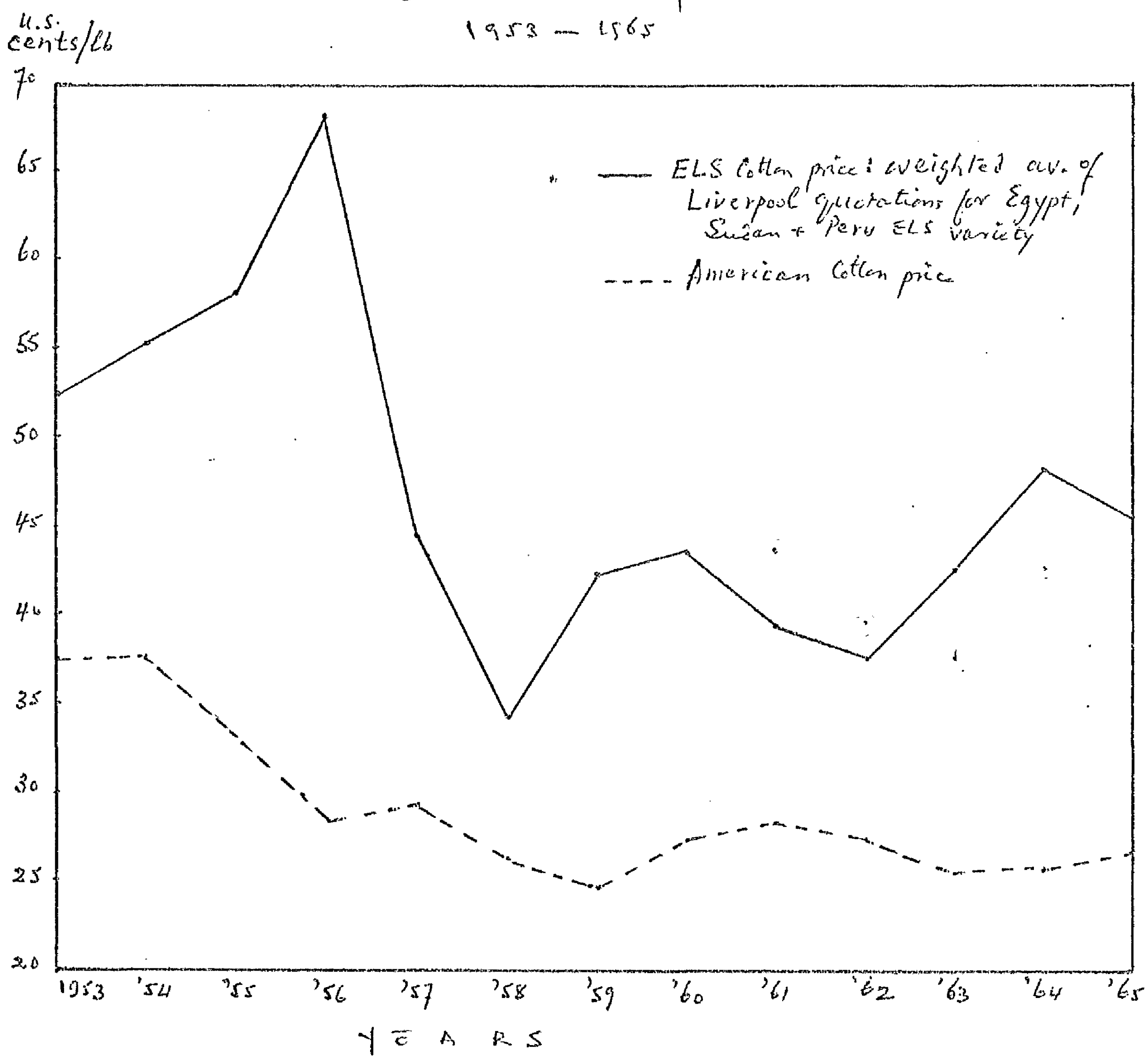
However, ELS cotton is the variety which suffered most, among other cotton staple lengths, from declining prices and increasing competition from both synthetics and short staple cottons. The instability of ELS cotton production resulting from its sensitivity to changing weather conditions and pest attack, imparts greater instability to its price. ELS cotton price is the most unstable among other natural or industrial fibres. This degree of instability is measured by calculating the coefficient of variation(1) for the prices of the fibres considered, as given in table (4.5) for the period of 1953-65.

Table 4.5. Price stability of ELS cotton, American cotton and Rayon 1953-1965

	Fibre	Coefficient of variation %
(1)	ELS Cotton	
	Weighted average of Egypt, Sudan and Peru Prices	21%
	Price of Egyptian ELS	22%
	Price of Sudan ELS	20%
(2)	American Cotton	
	Am. Middling	14.6%
(3)	Rayon fibres	
	U.K. Prices	4.2%
	France	5.7%
	W. Germany	6.4%
	Italy	10.6%

(1) Coefficient of variation = $\frac{\text{standard deviation}}{\text{mean}} \times 100$.

Chart (4.2): Price of extra-long (ELS) and American Cottons at Liverpool 1953 — 1965



While ELS cotton was subject to such price fluctuations, the short staple cotton exhibited more stable prices. The U.S. cotton policy contributed to stabilization of this variety as she has large stock pile as well as the lead in production, consumption and exports of the short staple. The result of such price instability was the growing competition of the short staple with ELS cotton which was accelerated by the development of spinning machinery that adjusts to various fibre lengths.

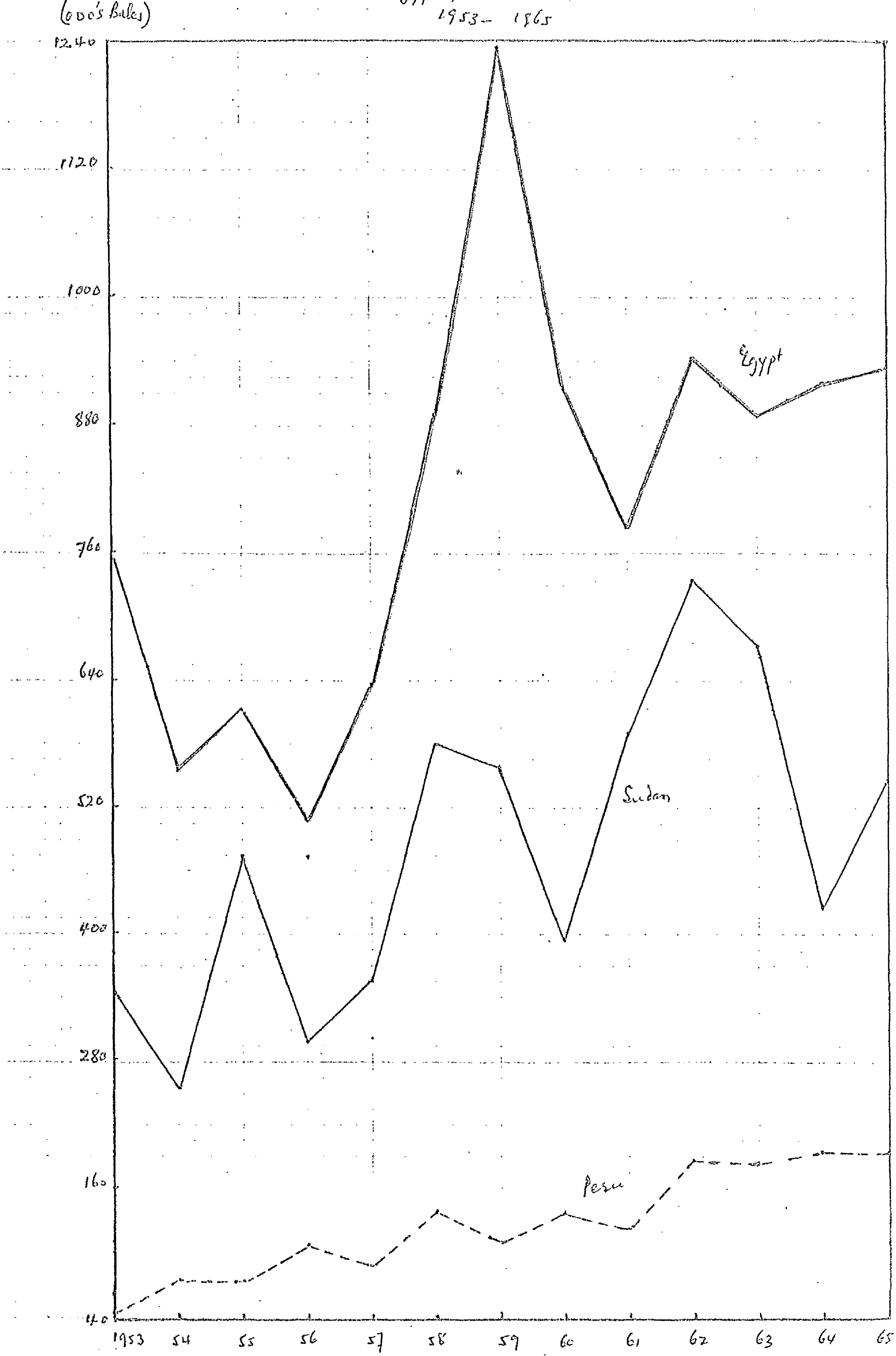
On the whole, the ELS price is declining, a fact which is reflected in chart no. (4.2) for Liverpool weighted average of price quotations of the three main varieties of ELS cotton: Karnak of Egypt, Sakel of Sudan and Pima of Peru.

(c) Sudan's Position in Cotton Trade

Though Sudan's share in international cotton trade as a whole is not very considerable yet her special position stems from the fact that she is the second largest producer of the ELS cotton variety. Sudan contributes over 1% of world cotton production but over 30% of world ELS cotton production. In fact, almost 98% of Sudan cotton is of ELS variety (1.3/8" and over) grown on irrigated land while the remainder is of the short staples; mostly rain grown.

During the period of study 1953-1965 Sudan has increased her share in ELS cotton production by almost doubling the area under cotton. Among the former big producers, (U.A.R., Sudan, Peru and U.S.A.), Sudan has vast potential to expand ELS cotton production.

Chart(4.3): [illegible] by Egypt, Sudan & Peru 1953– 1965



The completion of the Rosiers Dam in 1966 has made expansion more feasible, at least to the Ten-year plan target, referred to earlier, of one million feddan.

The following table shows the range of Sudan's share in exports of ELS cotton during the period of study:

Table 4.6. Shares of ELS Cotton world Exports 1953 - 1965

Country	range %
Egypt	51 - 66
Sudan	27 - 41
Peru	4 - 12

Source: Computed from I.C.A.C. Bulletin.

(d) Direction of Sudan Cotton Trade

Table (4.7) summarises the export markets to which Sudan cotton is consigned. From this table, during the period of study 1953-65, the developments that have taken place in the destinations of cotton exports are detected from the growth or decline of the respective market shares.

U.K. has been the traditional foreign market for Sudan cotton since its production in commercial quantities in Gezira and until the late 1950's. In fact, the concentration of Sudan exports of cotton in U.K. was favoured by big export markets opened to the British textile industry which resulted in shipping almost all the crop to the U.K. market. As is seen from table (4.7) this arrangement continued with a declining trend; notably from the 1960's when the British market absorbed only 20% of total cotton export figures.

Table 4.7.

Sudan Cotton Markets
Exports for Calendar Years (Jan. 1st - Dec. 31st)
1950 - 54 - 1965

(per cent)

Year / Country	1950-54	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	* 1965
U.K.	72.5	36	45.2	36	38.7	31.5	34	20.2	14.7	12.9	14.4	11.4
India	22.7	21	17.6	19.3	18.1	14.8	17.8	17	25.9	12.5	17	13.4
Italy	--	11.4	7.3	7	3	9.6	6.7	13.9	10.7	9.5	10.3	8.5
W. Germany	--	9	8	7	11.4	11.3	5.8	13.2	11.6	10.3	16	12.7
France	--	6.6	4.7	10.8	9.7	10.3	5.3	5	4.5	4.4	3.9	3.6
U.S.S.R.	--	--	--	0.3	--	3.5	5.1	8.7	7.9	10.3	3.4	8.9
China		1 } 6	0.4 } 3	4.7 } 8.8	2.9 } 6.5	1.7 } 10	9.1 } 20.4	2.5 } 16	8.0 } 20.4	8.6 } 27.1	6.7 } 18.3	15.6 } 31
Other Communist Countries		5	2.6	3.8	3.6	4.8	6.2	4.8	4.5	8.2	8.2	6.5
Yugoslavia	--	--	0.5	0.00	0.4	0.3	1.4	-	0.2	3.4	3.6	5.7
Japan	--	0.5	3	0.1	3	2.6	3.4	6.3	4.9	8.8	10.3	6
Others	4.8	9.5	10.7	11	9.2	9.6	5.2	8.4	7.1	11.1	6.2	7.7
Total	100	100	100	100	100	100	100	100	100	100	100	100
Total Quantity Exported (000's bales)	269	521	614	316	421	947	550	559	872	938	619	448

* Exports for a period less than one year (1.1.65 - 15.10.65)

Source: Compiled from (1) Ministry of Finance & Economics, Cotton Section, Sudan Cotton Review, Khartoum, 1965.
(2) Ministry of Finance & Economics, Sudan Cotton Bulletin, No. 196 of Oct. 1965.

India ranked second after U.K. in importing Sudan cotton. Other countries of Western Europe (France, W. Germany and Italy) have more or less accounted for the remainder. However, this pattern of Sudan cotton export markets has changed since the early 1960's. This change is reflected in the declining share of U.K.; India's position has remained stagnant, while a marked increase in the share of the centrally planned economies of Eastern Europe is an obvious feature.

Part of this redirection of Sudan cotton exports is due to the depressed textile industry of U.K. which has resulted in the loss of great parts of the latter's export and domestic markets. Besides, India's foreign exchange difficulties have been a limiting factor of any possible expansion of her share of Sudan cotton imports.

Such relative change in the direction of cotton exports was enhanced by the conclusion of a number of bilateral agreements with the centrally planned economies. This resulted in stepping up cotton exports to new outlets.

(e) Bilateral Agreements and Export Promotion

It was in the 1956/57 marketing season that Sudan entered into bilateral agreements with East European countries. Though with some differences both Sudan and the U.A.R. resorted to such bilateral agreements when they failed to sell all their cotton to traditional western markets whose demand for raw cotton showed some decline. The result on the whole was a favourable one for the export position of the cotton crop. Compared with all traditional markets, with the exception of India, Sudan's exports of cotton to Eastern countries including the U.S.S.R. have commanded high prices.(1) It was stated clearly in all these bilateral agreements that prices of goods exchanged will be established on the basis of world prices prevailing in principal markets.

However, these agreements are short term measures to help ease the pressing need for foreign exchange and import requirements. Despite their favourable effect, operating bilateral agreements is not without difficulties. In a document(2) surveying the experience of African countries, the Economic Commission for Africa pointed out the main problem as being basically that of balancing trade and bilateral payments position which is an essential condition for achieving the targets of the agreements. It is a supply and demand problem especially if the goods exchanged are consumer goods. Besides, most of the importing agencies in developing countries are foreign firms or branches of companies situated in Western Europe and may not be ready to import from the new sources. In other instances, prices may be relatively higher than what can be obtained from alternative suppliers. The net result may be frozen balances due to failure to achieve the trade targets aimed at in the agreements by one of the partners.

Bilateralism in the West is not a recognized tool of trade policy, while for the centrally planned economies it is a condition

(1) U.N. ECA: A survey of African Countries Bilateral Agreements, p. 56. DocumentE/Cn. 14/STC/24, Rev.

(2) Ibid., p. 58.

for trading with them. The justification may be sought in their reliance on planning ahead which means that they have to be sure of their supplies and commitments during the plan period.[1]

As most of Sudan's imports are drawn from Western markets (table 4.8), mainly the British market, it will hardly be in the position of having a favourable export volume to match the import bill from these markets. Any resulting deficit has to be paid from surplus realized with trade partners other than those of Western Europe whose demand for cotton imports from Sudan has been declining.

Bilateralism is accepted in such circumstances on the ground of promoting trade by making the goods available in other new markets. To make bilateralism more effective, the following conditions have to be taken into consideration:-

(i) Bilateral agreements should not divert commodities from traditional sources, rather they should help to dispose of surpluses and promote additional exports.

(ii) As a result, the elasticity of export supply should be increased so as to match the expansion in commodity markets.

(iii) More flexibility in pricing by providing periodic reviews so as not to cause price instability in the "free" market which makes buyers cut their consumption or look for other substitutes.

(iv) The ability and willingness of the other party to supply the goods required.

(v) Both imports and exports i.e. goods exchanged, are required in the market of each.

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(1) Singh, M. India's Export Trends, Chap. XI, p. 249-272, 1964.

Table 4.8.

Sudan's Main Suppliers
1958-1965
(L.S. 000's)

	1958	1959	1960	1961	1962	1963	1964	1965
United Kingdom	19,114	14,189	17,344	21,934	25,480	26,666	21,359	16,465
India	6,616	8,843	7,675	7,762	7,538	6,033	5,478	6,446
United Arab Rep.	3,477	4,552	5,339	5,404	5,543	3,126	4,531	2,808
Japan	2,478	608	1,622	4,809	5,222	5,845	6,630	6,747
Italy	1,439	1,954	3,339	3,800	5,109	5,632	3,278	2,417
Germany F.R.	3,445	3,643	5,193	8,280	5,007	6,137	7,706	3,793
U.S.A.	1,586	1,044	1,826	5,193	4,895	5,184	6,400	4,686
Netherlands	1,970	967	1,251	1,717	3,217	3,598	2,395	2,217
U.S.S.R.	166	997	2,287	3,082	2,926	4,351	1,259	2,406
Belgium	2,128	1,229	1,252	1,387	2,918	2,496	2,100	1,426
Czechoslovakia	1,205	1,244	1,086	1,261	1,593	1,123	955	1,306
China people's Rep.	521	899	772	1,631	1,327	1,483	2,259	2,282
France	1,459	2,292	1,840	1,297	1,259	2,276	3,522	1,562
Poland	825	424	352	900	1,247	2,160	1,776	1,313

Source: Economic Survey, 1962-1965, Ministry of Finance and Economics, Khartoum.

The seriousness and significance of the above mentioned conditions for operating bilateral agreements is substantiated by the lop-sided trade balances of Sudan with India and U.A.R. Although the latter is not an importer of Sudan cotton, the conditions for a favourable and effective agreement extend to trade in general.

The performance of these agreements between Sudan and the centrally planned economies did not create major difficulties as most of the purchases were for the Sudan Government's requirements.

However, if Sudan cotton exports to these countries are reviewed in the context of the previously mentioned conditions of bilateral agreements, the future outcome may be different.

The centrally planned economies seem to show some tendency to self-sufficiency[(1)] relative to the amount of cotton produced and traded among them (see table 4.9). This makes cotton a relatively inessential commodity in their import requirements from the rest of the world. Table 4.9 below gives the movement of domestic cotton production and consumption of these countries between 1955/56 and 1963/64.

Table 4.9. Production and Consumption of Cotton in Communist Countries 1955/56 - 63/64

(000's bales)

Year	PRODUCTION			CONSUMPTION		
	Eastern Europe and U.S.S.R.	China	Total	Eastern Europe and U.S.S.R.	China	Total
1955/56	6,285	6,300	12,585	6,788	5,900	12,688
1956	7,018	6,000	13,018	7,154	6,200	13,354
1957	6,813	6,800	13,613	7,622	6,800	14,422
1958	6,997	8,700	15,697	8,022	8,500	16,522
1959	7,513	8,500	16,013	8,365	8,700	17,065
1960	6,966	6,500	13,466	8,472	7,000	15,472
1961	7,135	5,000	12,135	8,637	5,400	14,037
1962	6,965	5,200	12,165	8,685	5,500	14,185
1963/64	8,105	5,500	13,605	9,055	6,200	15,255

Source: I.C.A.C., October, 1964.

(1) Cotton is one of the basic raw materials in the socialist camp. Therefore, and for the security of the camp, cotton requirements should be obtained from assured domestic sources inside the CMEA. Production of cotton and synthetic fibres is rapidly stepping up. In the Soviet Union, where most of Eastern Europe's cotton is grown, the acreage under cotton, planned for 1965, was reached in 1963. Further expansions are planned for 1970 and 1980. Yet all depends on the changing conditions and the resulting political atmosphere, growing cost consciousness, comparative advantage and revealed targets of the long term requirements of the commodity in question: Trade flows and Future prospects for Trade between the centrally planned economies and developing countries, A note made by the Economic Commission for Europe to the U.N. Conference on Trade and Development. Conference proceedings, Part I vol. VI, 1964, p. 210-215.

The production figures given in table 4.9 are mostly for cotton varieties other than the extra-long staple which constitutes the bulk of Sudan's cotton exports to these countries. No figures are available for ELS cotton production and consumption for purposes of comparison. Yet during recent years the consignments of ELS cotton from both Egypt and Sudan indicate that consumption has been increasing. For the year 1962/63 the consumption of ELS cotton in Eastern Europe and U.S.S.R. has been estimated as 1.5 million bales (of which 500,000 bales were produced in the U.S.S.R.). This gives a ratio of 16.5% of total cotton consumption in these countries during the year 1962/63. It is a very high proportion compared with the world average use of ELS, which ranges between 5% and 6% of all cotton.[1]

Certainly the centrally planned economies have a big market potential where incomes are rising and more consumption needs yet to be satisfied. ELS cotton is a good quality for fine cloth mostly demanded at higher preferences. Yet, the trends of the consumer goods plans in general and the fine cotton textile and synthetics industries in particular, make the future uncertain for committing too much of Sudan's ELS cotton via bilateral agreements with these countries. Bilateral agreements, like bulk sale, the previously practiced marketing policy in disposing of Sudan cotton to U.K., create a relative shortage of the commodity in other export markets. For ELS cotton this means higher and unstable prices which would speed up the already existing competition from other synthetic fibres. To an extent,

(1) I.B.R.D., <u>Report on extra long staple cotton</u> 1964, p. 29, 30.

this was the situation when U.A.R. in the mid-50's tied most of her ELS cotton to Eastern countries in repayment of debts, while rumours spread that these countries re-exported part of the consignments to the west.(1)

ELS cotton is no longer a commodity in relative shortage. Sudan's position can be strengthened by diversifying her exports with other enterprises besides cotton. And bilateralism is to be adopted as a trade promoter rather than shifting from the present export markets. The need to mention these two observations is due to the fact that most of the difficulties facing the Sudanese economy arose from the commodity concentration (cotton, of which 98% is of the special variety of ELS) and the geographic concentration of exports (the British Market). Unlike Egypt, where other reasons were involved, diversion of Sudan cotton trade took place entirely on account of the situation in traditional export markets. It was a response to the declining demand in the major market (U.K.) at a time when Sudan had almost doubled her production of ELS cotton.

II. Empirical analysis of demand for raw cotton.

(i) Choice of period and markets

The period of study has been determined by two considerations: first the availability of adequate data that could yield meaningful and reliable results. Second, the period chosen should reflect some homogeneity and continuity which make the resulting estimates reasonably stable and representative of the phenomena under consideration.

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(1) Hansen, B. & Marzouk, Development and Economic policy in U.A.R., 1965, p. 104. Reference to such incidence with India's exports is given in Nita Watts and Asha Dater, "The Development of India's Trade with the Soviet Union and Eastern Europe", Oxford bulletin of Economics and Statistics, Feb., 1968, p. 21.

Both the first and second conditions precluded the choice of a larger sample than the 13 years between 1953-1965. Before 1953 Sudan cotton was sold in bulk to U.K. Moreover the experiences of the Korean boom and World War II impart great influence to the forces underlying the marketing of cotton. Finally, it is since 1953 and after recovering from the effects of the abnormal conditions created by the Korean war, that the demand conditions and state of the cotton trade have been on the decline. This makes any study of the cotton market during such a period more relevant to a future view of the aspects of cotton production and the policies involved.

As for the selected export markets, beside the data considerations, these markets (U.K., France, W. Germany, Italy and India), account for the largest part of Sudan ELS exports to the market economies subject to conventional economic analysis. They represent Sudan's traditional markets of U.K. and India, while the other three are the important members of the European Common Market. Apart from India, cotton is not domestically produced in any of them.

(ii) Data and Method:

In empirical demand analysis the theoretical framework, very briefly, could be summed up as follows:(1) assuming rationality and maximization of utility, a consumer with a given income will choose among the alternative commodities or groups of commodities available to him in a certain market situation. By studying

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(1) - Hicks, J., Value and Capital, 1939, Chap. I-III.
- Henderson & Quandt, Micro-Economic Theory, 1958, Chap. II.
- Wold, J., Demand Analysis, 1953, Chap. II.
- Clarkson, G.P.E., The Theory of Consumer Demand, 1963, Chap. III.

his behaviour, the theory of demand aims at establishing what is known as the law of demand i.e. the demand function governing his behaviour. This demand function, therefore, includes the price of the commodity in question, consumer's income and the prices of the other goods. A trend variable is usually introduced to the demand function to account for the systematic unquantifiable or unspecified variables e.g. changing tastes and preferences of consumers. Before discussing the resulting estimates of demand functions, a brief note on data used and method of analysis is given.

The variables: (q) is per capita consumption of cotton (all types) in each of the selected markets. For Sudan ELS cotton the same notation (q) is used for per capita import except for India where aggregate import of Sudan cotton (Q) is the dependent variable.

(Pa) American cotton price at Liverpool, deflated.

(Ps) Sudan ELS cotton price at Liverpool, deflated.

(Pe) Egypt ELS cotton price at Liverpool, deflated.

(Pj) India Jarilla cotton price at Bombay deflated.

(Pr) Wholesale price of rayon fibres in the respective markets of the study. Quantity of rayon piece goods (Qr) is used for India, and (qr) for per capita rayon consumption.

(Y) per capita income figures (calendar years). Disposable income figures for (U.K. France, W. Germany), while at factor cost for Italy and India. All are deflated by cost of living index.

(X) Index of textile production per calendar year.

(S) Stocks of all cotton in each export market at the end of the period i.e. marketing season from August-July.

Price deflation

Prices are Liverpool quotations which are uniformly used for all markets. Liverpool is an international cotton market and with the difficulty of obtaining price quotations for each export market it is thought that Liverpool quotations are the closest approximations of general price trends.

While prices are available for each variety as is given above, there is no quotation for all cotton as such. Arbitrarily the American cotton prices are used in estimating the demand for all cotton. American cotton is the largest short staple variety widely consumed. U.S. with her position as the largest producer, consumer and exporter of this type is definitely the price leader. The price of rayon fibre is taken as representative of the effect of synthetics and industrial fibres in general. Rayon is and has been the keenest competitor with cotton fibres.

Prices of cotton and rayon are deflated. However, in some instances non-deflated prices are used in search of the maximum and best information to be derived from available data. Despite its satisfactory results, deflation is a correction applied to the series before using them, and since there is no uniform index which can be accepted as precise and perfect,(1) this makes deflation one of the alternatives to be attempted in estimation.(2) Previous evidence showed no drastic difference between deflated and non-deflated data,(3) particularly if a time variable were

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(1) Clark, C. and others Business and Economic Forecasting 1961, p. 73-74.

(2) Wold, J. Demand Analysis, 1953, p. 42.

(3) Schultz, H. Theory and Measurement of Demand, 1939, Appendix B, p. 711.

included in the equation to account for strong time trends in the series. The question is discussed from another point of view; money illusions.(1) Depending upon the size of income devoted to the commodity's purchase, the degree of inflationary pressures and hence the prevalence of money illusion, a choice can be made between absolute or deflated prices.

The following are the price deflators used for each market's data:

U.K.: All cotton prices are deflated by the wholesale index of import price of raw cotton 1954 = 100. Rayon is deflated by the wholesale price index of rayon fibres 1954 = 100. Cost of living index of 1954 = 100 is used for per capita disposable income.

France: Both cotton and rayon prices are deflated by raw materials indices. Wholesale price index 1953 = 100. Per capita income is deflated by the cost of living index 1953 = 100.

W. Germany: Cotton and rayon prices are deflated by the wholesale price index of consumers' goods industries 1953 = 100. Cost of living 1953 = 100 is used for per capita income.

Italy: Both cotton and rayon prices are deflated by wholesale price index 1953 = 100 while per capita income is deflated by cost of living index 1953 = 100.

India: Cotton prices are deflated by fibre wholesale price index 1952 - 55 = 100. Aggregate and

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(1) Koutsoyannis, A. "Demand Functions for Tobacco", Manchester School of Economic and Social Studies, 1963, Vol (31), p. 3.

per capita income are deflated by cost of living index 1953 = 100. No rayon prices are available for India, instead consumption of rayon piece goods (Qr) is used.

Estimating statistical function. After experimenting with various types of functions, linear, semi-logarithmic and double logarth., the latter was chosen for estimates of demand functions of raw cotton. The form of the estimating equation used was generally as follows:

$$q_i = A\, P_i^{\eta} P_j^{\alpha} Y_i^{\lambda} e^{rt}$$

where

q_i = dependent variable in per capita terms of cotton, (i) refers to the type of cotton in the equation, i.e. all cotton or Sudanese

P_i = price of cotton for which the estimate is made

P_j = price of other cotton (substitutes: Egyptian, American, Indian or rayon fibre)

Y_i = per capita income in the market in question

e^{rt} = exponential time trend to the base e.

The equation is fitted as linear in logarth, as

$$\log q_i = \log A + \eta \log P_i + \alpha \log P_j + \lambda \log Y_i + rt \log_{10} e + u$$

(u = an error term as the relation is not expected to be exact).

The analysis was undertaken in step-wise multiple regression where independent variables were added one after the other. Judged by their contribution to the statistical significance of the regression coefficients and goodness of fit, i.e. increasing

$\bar{R}^2$, a conclusion is reached whether to consider them important to the analysis.

It is the absence of a clear cut a priori specification that makes plausible the step-wise multiple regression and attempts with different alternative combinations of the independent variables. However, the resulting best estimates should satisfy both economic and statistical requirements.

(iii) STATISTICAL ESTIMATES OF DEMAND FUNCTIONS:

(a) Demand functions of raw cotton (all types in the selected export markets

The demand for raw cotton is a derived demand. In order to assess the intensity of this demand, a prior insight to the demand for cotton textiles (greatest share of the cotton fibre) would seem appropriate. However, in a preliminary attempt to estimate this demand for cotton textiles in the export markets selected for the study, no significant results that could yield meaningful and reliable conclusions were obtained. Instead, estimates of demand for consumption of all cotton is made.

As the main theme of the present study is Sudan's cotton, it was thought appropriate to attempt a more general estimate of the demand for all types of cotton and then a separate estimate for Sudan's ELS variety which is a small part only. This procedure may be more revealing than the one estimate for all types of cotton or Sudan variety alone in the export markets considered.

The following table summarizes the results obtained for the demand functions of all types of cotton in the markets indicated.

Table 4.10.

Demand functions of Raw Cotton (All types) In U.K., France, W. Germany, Italy & India (1953 - 1965)

Eq. No.	Market	Equation fitted	$\bar{R}^2$	$\frac{\delta^2}{S^2}$
(4.1.1)	U.K.	$\log q = 6.7582 - \underset{(0.2707)}{0.0064} \log Pa_{(t-1)} + \underset{(0.6741)}{0.9457} \log Pr - \underset{(0.4135)}{2.2369^{*}} \log Y$	0.91	2.316
(4.1.6)	France	$\log q = 4.2877 - \underset{(0.1424)}{0.4173^{*}} \log Pa_{(t-1)} - \underset{(0.1976)}{0.4382^{**}} \log Pr - \underset{(0.1171)}{0.6160^{*}} \log Y$ $- \underset{(0.0719)}{0.1397^{**}} \log S_{(t-1)}$	0.75	2.452
(4.1.10)	W. Germany	$\log q = 3.7849 - \underset{(0.3385)}{0.5758} \log Pa_{(t-1)} + \underset{(0.6497)}{0.3762} \log Pr - \underset{(0.2497)}{0.5232^{**}} \log Y$	0.32	1.232
(4.1.15)	Italy	$\log q = 0.4006 + \underset{(0.5015)}{0.4964} \log Pa_{(t-1)} - \underset{(0.5491)}{0.8854} \log Pr + \underset{(0.2409)}{0.3329} \log Y$	0.38	2.063
(4.1.19)	India (1953-1964)	$\log q = -1.2691 - \underset{(0.0175)}{0.0742^{*}} \log Pa_{(t-1)} + \underset{(0.1485)}{0.5300^{*}} \log Y + \underset{(0.0305)}{0.2477^{*}} \log S_{(t-1)}$	0.88	1.532

* Significant at 5% level.
** Significant at 10% level.

All $\frac{\delta^2}{S^2}$ indicate no evidence for autocorrelation at 5% level.

Before discussing the results, the following remarks are worth mentioning: (q) the dependent variable in all the equations in table 4.10 is per capita consumption of all types of raw cotton. Prices $Pa_{(t-1)}$, Pr are non-deflated absolute prices in U.K. and France, estimates only. The index of textile production (x) has been used in the fitted regression equations. The use of (X) is suggested by the fact that cotton is an industrial raw material the demand for which would depend, among other things, on the level of activity in the textile industry. The results given in table 4.10 are the best fits of all the alternatives attempted for the combinations of variables in each market.

Price as an explanatory variable

Of the five markets investigated, cotton price turned out to be a conclusively significant explanatory variable in two cases: France and India. As shown in table (4.10) above, the resulting price elasticities are (-0.4173) and (-0.0742).

The price regression coefficient in the cases of U.K., W. Germany and Italy in table (4.10) is not significant. However, in the estimates shown in appendix A, significant coefficient of price has been obtained for W. Germany (equation nos. 4.1.12 and 4.1.13) and Italy (equation no. 4.1.16). Their price elasticity seem to be as (-0.6) and -0.38) respectively.

Broadly speaking, the results obtained for the different markets suggest that the demand (consumption) for all types of cotton is inelastic. More production and increasing export quantities of cotton fibre to the market would most likely depress prices.

Income as explanatory variable:

Apart from the Italian market, income is a significant explanatory variable in all the markets studied and shown in table (4.10). However the role played by this variable is not the same in all of them.

In U.K., France and W. Germany, the income regression coefficient retains a negative sign. This means that per capita consumption of cotton (all types) has a negative income elasticity in these markets. The result is confirmed by the negative coefficient of the time trend in the cases of U.K. and W. Germany. In these markets the time trend coefficient indicates a downward shift in the demand for all types of raw cotton. Both the income variable and the time trend are highly correlated and when introduced into the same one equation they influence the significance of each other (equations nos. 4.1.2, 4.1.11 and 4.1.12, table (1) App. A).

For Italy and India, the income variable coefficient suggests a positive income elasticity for per capita cotton consumption, though non-significant in the case of Italy. On the other hand, the index of textile production (X) proved to have a positive and significant relation with per capita consumption of raw cotton only in Italy and India while its effect in U.K., France and W. Germany is negligible (equations nos. 4.1.17, 4.1.18, 4.1.21, 4.1.22, 4.1.4, 4.1.9 and 4.1.14 respectively, App. A).

Taking into account the structural difficulties and decline experienced by the U.K. textile industry and to a lesser degree in France's and that the estimated income elasticity does not strictly depict the relation between per capita consumption of raw cotton and income as the former includes a percentage, the products of which are exported, one could conclude as follows: in the developed countries of Western Europe (U.K., France and W. Germany) the evidence suggest that the demand for raw cotton (all types) is declining and cotton is assuming less importance as an industrial raw material. This conclusion seems to be in line with the belief that the demand for primary products declines with higher levels of industrial activity and growth of income.

On the other hand both Italy and India represent a relatively developed and developing model of countries where with increasing textile production and rising incomes more raw cotton would be consumed. India is the only country of the five studied that produces cotton.

Competition with synthetics:

Rayon prices were introduced into the demand functions to test the degree of competition with consumption of all cotton. Prices instead of quantities of rayon consumed were taken as the prices of all fibres that make the producers decide which fibre to use. This is termed fibre substitution when contrasted with fabric substitution,[1] the latter being the amount of each fabric consumed at the shop level i.e. preferences of consumers.

(1) Ferguson and Polasek, "The elasticity of import demand for raw apparel wool", Econometrica, 1962, p. 760.

However, the results obtained are not conclusive. The cross elasticity coefficient of rayon prices (Pr) show signs of substitution only in the estimates of U.K. and W. Germany i.e. regression coefficients of (Pr) have positive signs but are statistically non-significant.

As a matter of fact the tendency towards substitution and competition has been observed on the aggregate world level consumption of both fibres, cotton and synthetics. In table 4.1 before it has been shown that during the period of 1953 - 1962 world cotton consumption has relatively lost ground to both rayon and synthetics (non-cellulostic). Yet the data used for the individual countries studied did not yield confirming evidence. This leaves room for a proper specification of the man-made fibres variable which it may not be possible to detect by prices of rayon alone.

The textile industry is becoming a more multi-fibre industry than before. The interdependence between its different sections is greater than what used to be. The significance of this is that it greatly influences the rate of substitution among the different apparel fibres. Cotton is increasingly blended with other man-made fibres. Another factor that affects the rate of substitution is attributed to the producers' attitude towards the marketing of the man-made fibres. Their notion is to create the demand in the shop and the goods will flow.(1) Coupled with price reductions and promotional efforts, the threat to cotton becomes more direct and great. Most important is the existence of unutilized excess capacity which is shown in table 4.11 below. Undoubtedly excess capacity is a potential cost reducer. With the growth of demand unit cost would be reduced due to the economies of scale and the resulting decrease in average fixed costs per unit.

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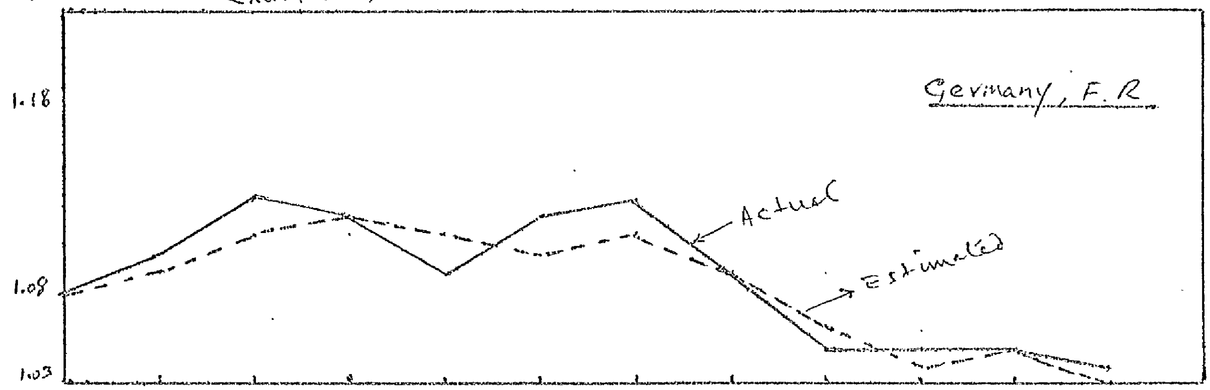
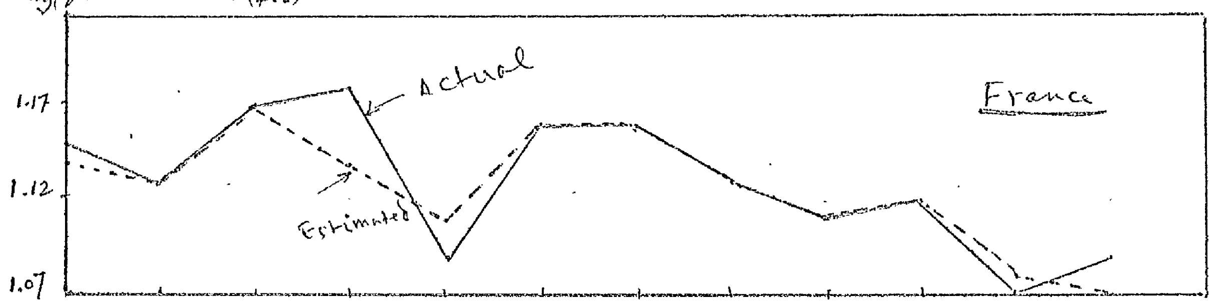
(1) Duxburry, D., "Natural and Synthetics are one family: World fibres", Special issue of The Financial Times (No. 24292), July

Actual vs. Estimated per capita Consumption of all types of Cotton

log.(q) chart (4.6)



log(q) chart (4.5)



log(q)

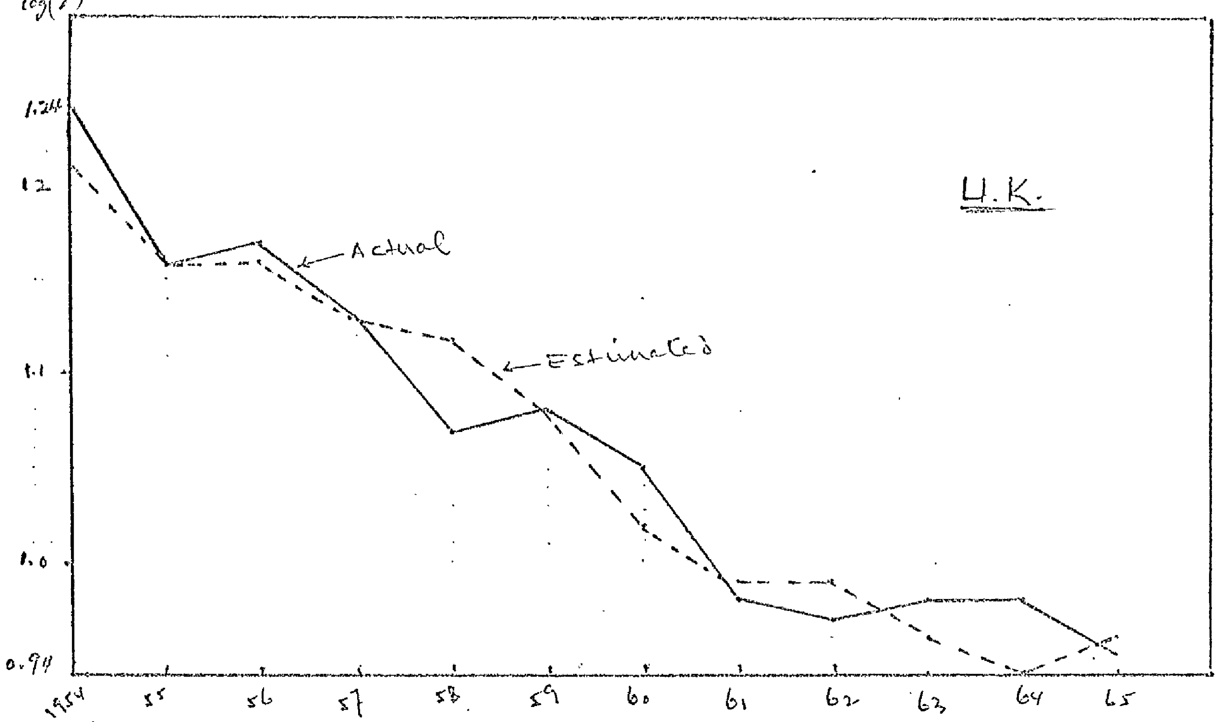
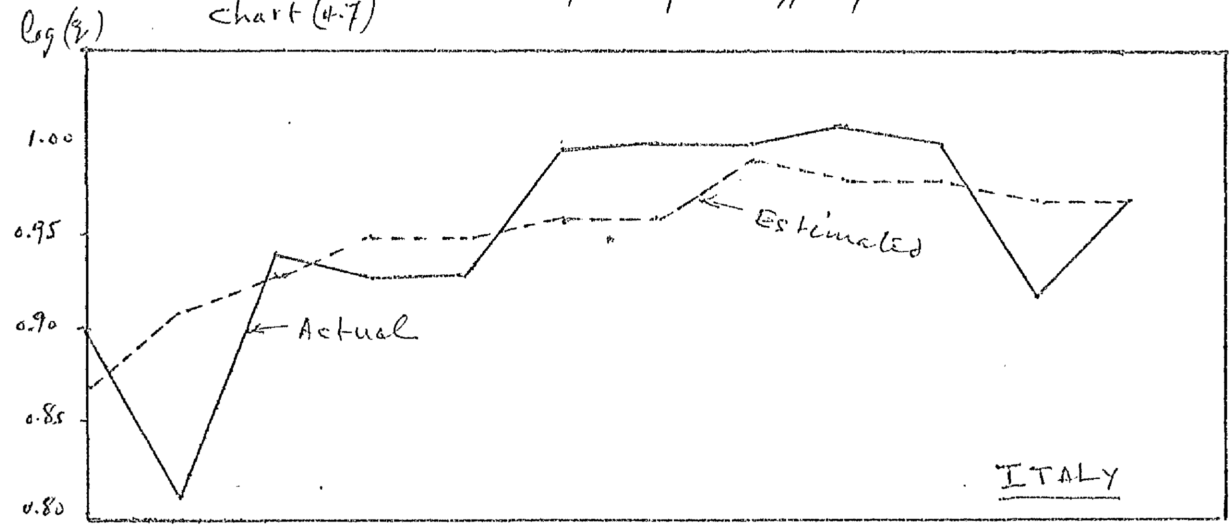


chart (4.4)

Actual vs Estimated per Capita
Consumption of all types of Citrus

chart (4.7)



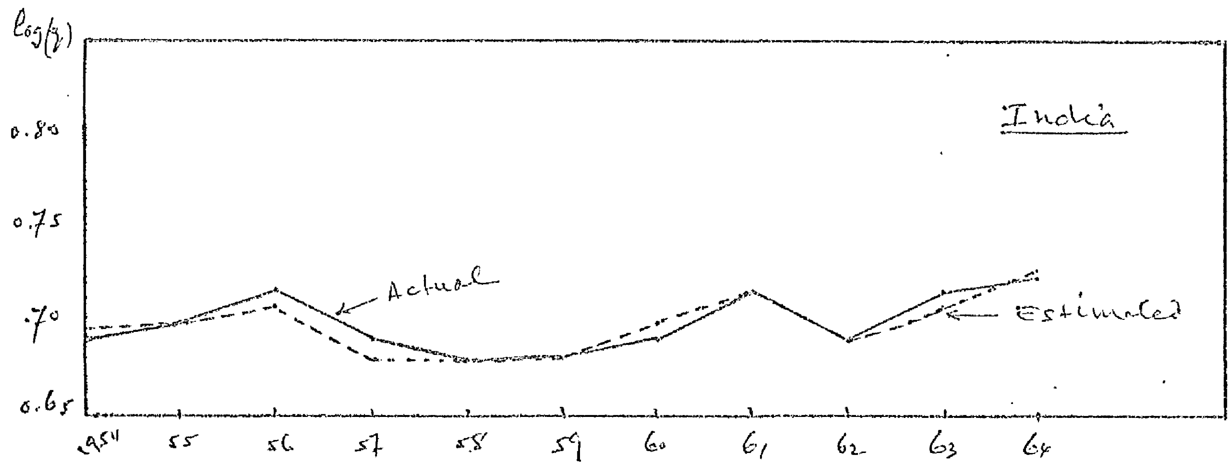


Chart (4.8)

Table 4.11. M.M. Fibres Capacity and Production in major developed countries (U.S., U.K., EEC and Japan)

(000's m.tons)

Capacity	Cellulosics Staple Fibre	Cellulosics Continuous Filament	Cellulosics Total	Synthetics Staple Fibre	Synthetics Continuous Filament	Synthetics Total
1966	1631	983	2614	1141	1451	2592
1965	1601	955	2556	877	1063	1940
1964	1522	922	2444	670	871	1541
Production						
1954	1252	865	2117	643	835	1478
Prod./Cap. Ratio						
1964	82.3	93.7	86.6	96.1	95.9	96.0

Source: F.A.O. Commodity Review 1966, p. 172.

(b) World Demand for ELS Cotton

This is the variety to which 98% of Sudan's total cotton production belongs. The need to know something about the aggregate world demand before embarking upon estimates of demand for Sudan cotton in the respective individual export markets, is justified as follows: ELS is a homogeneous commodity, produced mainly by a small number of countries (Egypt, Sudan and Peru). This makes the ELS cotton market subject to conditions of homogeneous oligopoly.

Under such circumstances the overall elasticity of demand is more important than the individual market share's elasticity.(1) Output and price decisions are not independent from those of other producers as is the case with monopolistic oligopoly.

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(1) P. Sylos-Labins, "Prices and Wages: Theoretical and Statistical Interpretation of Italian Experience", Journal of Industrial Economics, 1967 (April) Vol. (XV) No. (2), p. 115.

Moreover ELS is an internationally traded commodity. And if it is assumed that consignments to the centrally planned economies[(1)] are made according to world prices prevailing at the time of sale, an aggregate world demand function for ELS will make for a better understanding over and above what is obtained from individual market studies of the West selected for Sudan's ELS cotton analysis.

However, in what follows, two estimates are given for world demand, viz: World and World excluding Eastern Europe. This distinction is given in most U.N. and international publications. However, for the purpose of the demand analysis, total annual exports of ELS of the three producers (Egypt, Sudan and Peru) who account for almost total world trade have been broken up arbitrarily to follow that distinction.

Variables

Total exports of Egypt, Sudan and Peru (Q) is the dependent variable for the world demand function. (Q') is the corresponding variable for the world excluding Eastern Europe. This is arrived at by adding Egyptian ELS cotton exports to Western Europe (U.K., France, W. Germany, India and Italy) to the exports of both Sudan and Peru. What makes (Q') a proxy variable is the cancelling effect between Sudan ELS consignments to Eastern Europe and Egyptian consignments to countries in Western Europe other than those taken into account.

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(1) Centrally planned economies, Eastern Europe and Communist countries are used interchangably.

(P_{els}) Price of ELS is an average weighted by the amount of exports of each country of the three. Prices are Liverpool quotations for Karnak, Sakel and Pima.

(Q_r) is world aggregate consumption of rayon, while indices of textile and industrial production for both divisions of the world are (x_{w1}/x_{w11}) and (x_{w2}/x_{w22}) respectively.

Using the double logarithmic estimating equation, the following are the results obtained:

Table 4.12. World Demand for ELS Cotton 1953 - 1965

Eq. No.		Equation fitted	$\bar{R}^2$	$\frac{\delta^2}{S^2}$
(4.2.1)	World	$\log Q = 3.6014 - \underset{(0.2218)}{0.\overset{*}{8}373} \log P_{els(t-1)} + \underset{(0.1853)}{0.\overset{**}{4}572} \log x_{w_2}$	0.78	2.134
(4.2.11)	World excluding E. Europe	$\log Q' = 2.0245 - \underset{(0.2502}{1.\overset{*}{0}968} \log \left(\frac{P_{els}}{P_a} \right)_{t-1} + \underset{(0.2131)}{0.\overset{**}{5}629} \log x_{w22}$	0.67	3.192

* Significant at 1%

** Significant at 5%

$\frac{\delta^2}{S^2}$ is significant at 5% indicating no evidence for autocorrelation.

Both estimates are statistically significant. The price assumes a greater role in explaining the variations in ELS cotton world demand. Absolute (Pels) or relative $(\frac{Pels}{Pa})$, i.e. ELS cotton price to short staple American price, account for 50% or more of the changes in the quantity exported each year.

More revealing is the influence of the relative price of ELS cotton to short staples in the non-communist world. Its regression coefficient gives a cross price elasticity slightly greater than unity (-1.0968), while the direct price elasticity is less than unity (-0.8373) as is shown in table 4.12 above.

This finding has a direct bearing on the degree of competition between ELS cotton and short staple, much of which is determined by their price ratio $(\frac{Pels}{Pa})$. According to the cross elasticity obtained before, a 1% increase in the relative price $(\frac{Pels}{Pa})$ would lead to more than a 1% decrease in the quantity of ELS cotton exported to the world market.

In a previous study on Egyptian cotton,(1) the following result was obtained for the world demand for ELS cotton between 1935-1955 with the exclusion of the war years 1940-1945:

$$E_L = 200.690 - \underset{(0.042)}{0.110}\, P_e - \underset{(0.112)}{0.365}\, T_W \qquad \bar{R} = 0.63$$

where:

E = annual exports of Egyptian long staple cotton

P = Price of Egyptian long staple cotton

T_W = World Index of Textile Production

The conclusion arrived at was: that the world demand for Egyptian cotton is inelastic. At the mean values of the price and quantity variable in the above equation the elasticity was computed as (-0.24).

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(1) Shayal, S.E.M., An Econometric Study of Price formation and Demand for Egyptian Cotton, Unpublished Ph.D. Thesis, Oxford, 1960.

This result can be compared to the one derived in the present study as both estimates deal with the same variety of cotton i.e. ELS cotton. As Egypt is the largest producer, the name (Egyptian cotton) has been fairly identified with the extra long staple variety.

In comparing the two estimates[1] one would find the following: while the world elasticity of demand for ELS cotton was very inelastic (-0.24) during the period 1935-1955, it turned out to be much less inelastic (-0.8373) for the recent period 1953-1965. This result would suggest the conclusion that long-run demand for ELS cotton is more elastic than would be the case in the short run. Such elastic demand may be caused by using more of other fibres in substitution for ELS cotton. With the price differential advantage, the reliance on ELS cotton fibres will be reduced over time.

Instability of ELS cotton prices caused by interventionist policies of the largest producer (Egypt), and the sharply fluctuating output of Sudan, resulted in a greater tendency to substitute ELS cotton with shorter staples and man-made fibres. From the analysis above it has been shown that the cross elasticity of the relative price $(\frac{Pels}{Pa})$ is greater than unity. And as most spinners still prefer ELS cotton as a quality cotton, much of this demand will depend, among other things, on the stability and price differential of ELS cotton. Both price stability and differential, undoubtedly, influence the level and stability of the spinners' profit margin.

The second explanatory variable of ELS cotton world demand is the index of manufacturing production. In both the estimates shown in table 4.12 above, ELS cotton will be demanded with rising levels of

(1) Though estimates derived from linear equations are generally less than their counterparts derived from double log. equations, the comparison could be reasonably made because the estimate of the present study is so large; (-0.8373), even if allowance is made for the downward bias in the linear form estimate of (-0.24).

activity in the world. This is illustrated by the significant positive regression coefficients of both the index of textile production and of manufacturing (income effects).

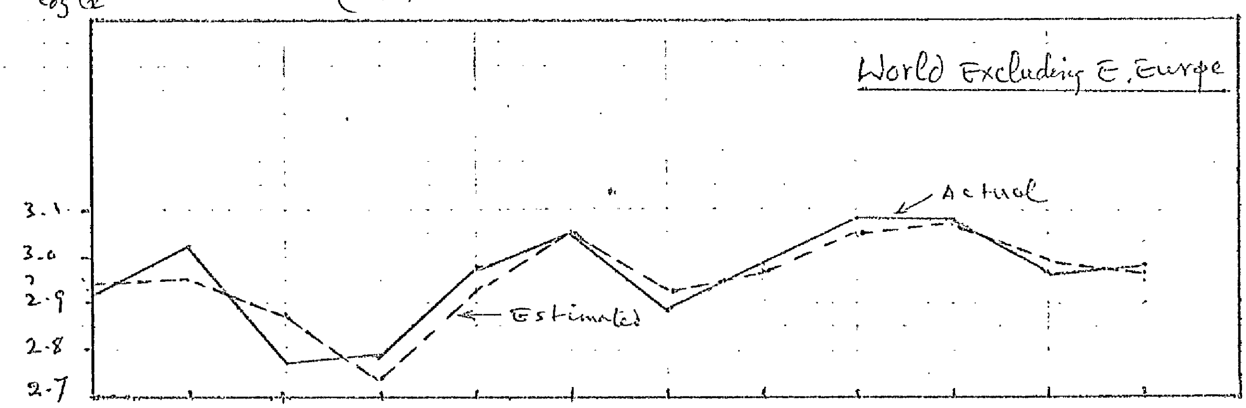
From the equations in table 4.12 above, the regression coefficient of industrial production indices (x_{w2}) and (x_{w22}) are significant at the 5% level. They indicate that ELS is a non-inferior commodity that can be in inverse relation with the level of activity in both estimates of the world. However, the growth of ELS demand will be slower than the growth of manufacturing production. Both elasticity estimates with respect to indices of industrial production are less than unity (-0.4572 and 0.5629) for all world and non-communist world respectively.

As for competition of synthetic fibre with ELS cotton, equations (4.2.4 and 4.2.14) in appendix (A) include besides the price variable of ELS cotton another variable (Q_r), aggregate world consumption of rayon. In the two equations it has a significant and positive regression coefficient at the 5% probability level. This reflects that keen competition on the world level is not confirmed for the period of study, 1953-1965. Instead, ELS consumption is increasing with every increase in rayon consumption, other things held constant.[1]

The validity of such results for both world divisions may be questioned once the individual countries' demand functions are studied (later when Sudan ELS cotton is analysed for its export markets), but in analysing the demand for an international homogeneous commodity like ELS cotton, such an overall estimate

(1) The negative sign retained by the regression coefficient of aggregate rayon consumption (Qr) when introduced to the equation with the index of industrial or textile production does not stand as evidence for competition with ELS cotton. The result is non-significant due to high intercorrelation between (Qr) and each of the world industrial and textile production indices. In each case r = 0.9 with (Qr).

Chart(4.10)



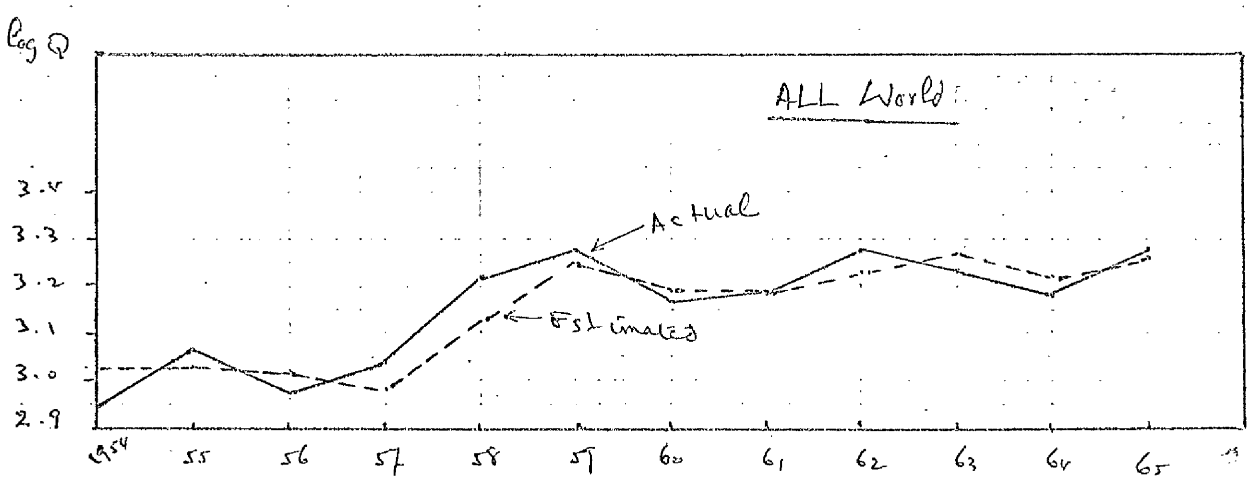


Chart (4.9) Actual vs. Estimated ELS Cotton Exports to the World of demand beside the individual countries' estimates adds more information and insight to the position of the commodity in the market.

ELS cotton is the fibre that produces fine apparel cloth usually demanded with rising standards of living and higher incomes. In this context the aggregate concept of the world conceals a great deal. Standards of living and income levels are so diverse, centres of synthetic fibre industries are concentrated in a few countries and finally consumers' preferences change according to the former factors.

On balance, ELS cotton world demand showed an increasing trend during the period of study. In equations (4.2.10 and 4.2.18 Table (2) App. A), the coefficient of time is significant and positive at 5%. Of the two world estimates, the significance of the time shifter in the equation of the non-communist world is worth noticing. It is these countries which have been the traditional consumers of ELS and in which demand is said to be on decline. The time regression coefficient indicates an annual upward rate of increase of 3.2% and 3.1% for the two world estimates respectively.

(c) Demand Functions of Sudan ELS Cotton

The foreign export markets of Sudan cotton selected for this study (U.K., France, W. Germany, Italy and India) accounted for more than 70% on the average of total annual exports during the period of study (see table 4.7 before). It is only in the last 3 years, 1963, 1964 and 1965 that the lower limit of the range (50%) of their share in Sudan's cotton exports was reached.

Due to the special position of Sudan as the second largest producer of ELS in the world and her reliance entirely on export markets, a study of the performance of exports during the elapsed period 1953 - 1965 is deemed necessary.

The results given in table(4.13) are chosen as the basic equations of the various combinations of regression attempted:

Table 4.13.

Demand Functions of Sudan ELS Cotton In Selected Export Markets 1953-1965

Eq. No.	Market	Period	Equation Fitted	$\bar{R}^2$	$\frac{\delta^2}{S^2}$
4.3.1	U.K.	1953-1965	$\log q = 11.8017 - \underset{(0.5689)}{0.6847} \log Ps - \underset{(0.8108)}{4.3215^{*}} \log y$	0.73	2.256
4.3.9	France//	"	$\log q = 5.0274 + \underset{(0.3971)}{0.1500} \log Ps - \underset{(0.9053)}{4.3623^{*}} \log Pa + \underset{(0.8058)}{4.2501^{*}} \log Pr$	0.71	2.769
4.3.16	W. Germany	"	$\log q = 10.4978 - \underset{(1.9961)}{6.8534^{**}} \log Ps + \underset{(1.6181)}{4.2279^{**}} \log Pe - \underset{(1.6111)}{4.7182^{**}} \log Pa$ $+ \underset{(3.8914)}{10.1156^{**}} \log Pr + \underset{(1.2912)}{0.6251} \log y$	0.80	2.714
4.3.22	Italy	"	$\log q = 1.6333 - \underset{(2.6327)}{13.5376^{*}} \log Ps + \underset{(2.5716)}{12.0260^{*}} \log Pe$	0.67	3.128
4.3.31	India ∅	1953-1964	$\log Q = 20.5358 - \underset{(1.4982)}{5.7294^{**}} \log Ps + \underset{(1.1855)}{3.4909^{**}} \log Pe - \underset{(0.9616)}{1.9775^{***}} \log Pa$ $+ \underset{(1.4997)}{3.1439^{***}} \log Qr - \underset{(2.8727)}{7.7903^{**}} \log Y - \underset{(0.25360)}{0.44885}\, t$	0.71	2.252

* Significant at 1% level
** Significant at 5% level
*** Significant at 10% level.

All $\frac{\delta^2}{S^2}$ indicate no evidence for autocorrelation at 5% significance level.

// France's cotton price variables (Ps) and (Pa) are non-deflated absolute prices.

∅ Income variable (Y) in India is aggregate and not per capita income.

As the equations fitted are double-logarithims, the regression coefficients of the estimates are the respective elasticities of the demand functions with the explanatory variables in the relation. The non-uniformity of the independent variables included in the demand equations shown in table (4.13) is due to the fact that various combinations of these variables or their transformations were used alternatively in search of more acceptable results.

However, the fundamental form of the model is preserved, i.e. per capita import of Sudan ELS cotton is a function of its price, the prices of substitutes and the level of activity in the export market in question. As each of the selected export markets has accordingly manifested its special effect on the estimating demand function, discussion of the results of table (4.13) will be made on a country-wise basis instead of explanatory variable-wise (price, income etc..).

(1) U.K.

Equation (4.3.1.) in table (4.13) above explains 73% of the variations in U.K. demand for Sudan ELS cotton. In most of the U.K. demand functions attempted, both per capita income (Y) and index of textile production (X) emerged as the only important variables in determining the demand level. Both (Y) and (X) have negative and significant (at 5%) elasticities with U.K. per capita imports of Sudan ELS cotton. (See table 3 Appendix A.)

These estimates taken at their face value imply that ELS cotton is an inferior commodity in U.K. market. With rising income the demand will be drastically curtailed and a prosperous textile industry in U.K. will use less and less of ELS as an industrial raw material.

The marked change of U.K. as a traditional market for Sudan ELS is explained by the difficulties experienced by the Lancashire cotton industry. These difficulties were detrimental to consumption of raw cotton and hence caused a sharp decline in all cotton products. Table(4.14) summarises this trend.

Table 4.14 The Decline in Cotton Yarn & Cloth Production 1951 = 100 (index)

	1949	1951	1953	1955	1957	1959	1961	1963
Yarn	91	100	85	80	79	67	60	53
Cloth	91	100	83	81	74	61	56	46

Source: Oxford Economic Papers No. 3, 1966, p.313, Economic problems of the British textile industry by Vibert, F.

The consequence of such decline is the loss of the export markets as well as a great part of the domestic market. Supplies to the U.K. domestic market came from India, Pakistan, Hong Kong and Portugal.

These are the regions with cheap labour, a favourable condition for costs and competitiveness in world markets. Between 30% and 50% of home market supply of grey cloth and made up goods came from India, Pakistan and Hong Kong. With her special position between the Commonwealth and E.F.T.A. organisations, U.K. could not stop the flow of imports from these countries in response to the complaints of the British textile producers who always attribute their industry's difficulties to the growing competition of imports from cheap labour sources.

In his study of the problems of the cotton industry, Vibert(1) argues that the decline in U.K. production is not mainly due to competition from abroad. They are due to structural difficulties of the industry itself. He puts special emphasis on the lack of sufficient investment, salesmanship, export oriented production and flexibility in adjusting the capital and labour in the industry to maximum use.

The significance of these factors in causing a decline in the U.K. textile industry (on top of that created by cheap imports), is noticeable when her exports are compared with other high labour cost countries.

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(1) Vibert, F. "Economic Problems of the Cotton Industry", O.E.P. 1966, Vol. (8).

Table (4.15) shows a great decline for U.K. exports with respect to others (see also table 4.16 below):

Table (4.15) Index of Cloth Exports
1954 = 100

	1950/51	1954/55	1958/59	1962/63	1964
U.K.	133	94	58	36	33
U.S.	111	95	80	63	63
E.E.C.	114	96	90	104	n.a.

Source: Oxford Economic Papers No.(3), 1966, p.318.

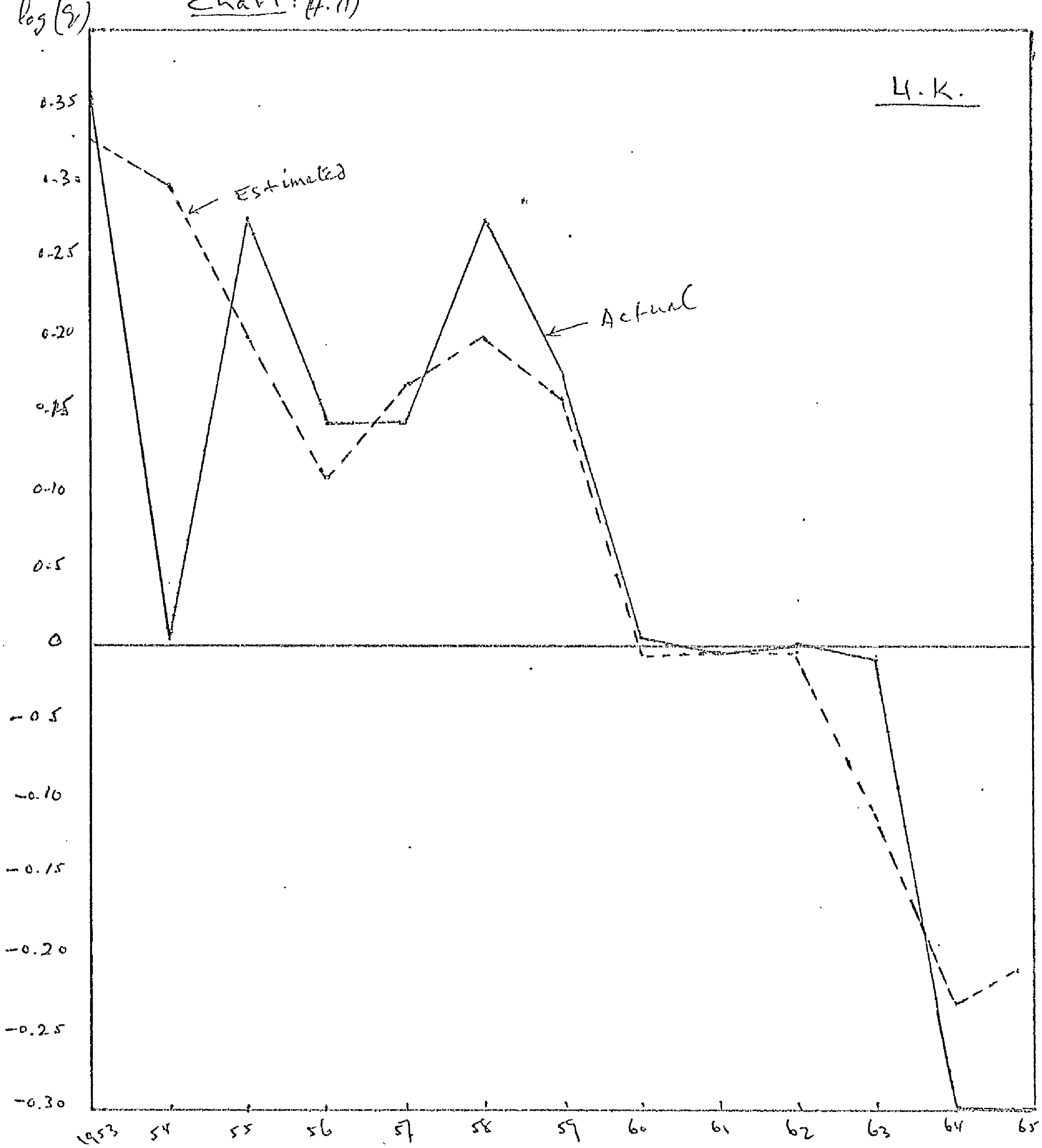
Therefore the prospects for ELS cotton are thus aggravated by the U.K.'s present loss of export markets, dwindling textile industry and the balance of payments difficulties that restrict non-paying imports. On the other hand the British Government is taking measures to alleviate the situation. Examples of these are the quota agreements with cheap imports suppliers (India, Pakistan, Hong Kong and Portugal) and the Government announcement (July 1967) of her intention to participate in different industries especially those facing some difficulties. If such optimism materialises, a revival of the fine cotton industry will favour the demand for ELS cotton.

(1a) Price Elasticity

In all the estimates attempted for U.K. demand for ELS raw cotton the price variable (Ps) did not attain the required level of significance though it retained the expected negative sign. In fact as has been explained before, during the period of study other factors than price of cotton dominated and largely determined the U.K. demand for ELS cotton of Sudan.

Actual vs. Estimated Per Capita imports of Sudan ELS Cotton

Chart: (4.11)



(1b) Competition with short staples and synthetics

No active competition was observed between ELS and the American cotton variety. However, the relative price variable $(\frac{P_s}{P_a})$ or (P_a) alone did not give any significant cross elasticity coefficient. It changed signs without any conclusive indication of direction.

No other ELS variety was included as a substitute as Egyptian ELS disappeared from U.K. during the period of the study 1953-65.

The cross elasticity of ELS with respect to rayon (P_r) retained a sign that points to substitutability. (P_r) turned out to be significant at 5% in only one equation (No. 4.3.3. table (3) Appendix A).

A time trend introduced to the demand equations indicated a downward shift during 1953-65 (Table 3, Appendix A). While this could be interpreted as changing tastes and preferences, yet the adverse impact of the state of the cotton textile industry on ELS demand cannot be ignored. For that matter the negative income elasticity referred to earlier cannot be taken as an indication of consumers' real income elasticity of demand for fine cotton textiles made of ELS cotton.

(2) France

The French market is not an important export market for Sudan ELS. Even so, their imports have been declining from what they used to be in the early years of this study (see table 4.7 above).

In the demand functions fitted to estimate France's demand for Sudan ELS, only American cotton price (P_a) and rayon price (P_r) explained most of the variations in (q). Sudan ELS price (P_s), Egypt ELS price (P_e), per capita income (Y) and index of textile production (x), all turned out to be insignificant in determining the demand function.

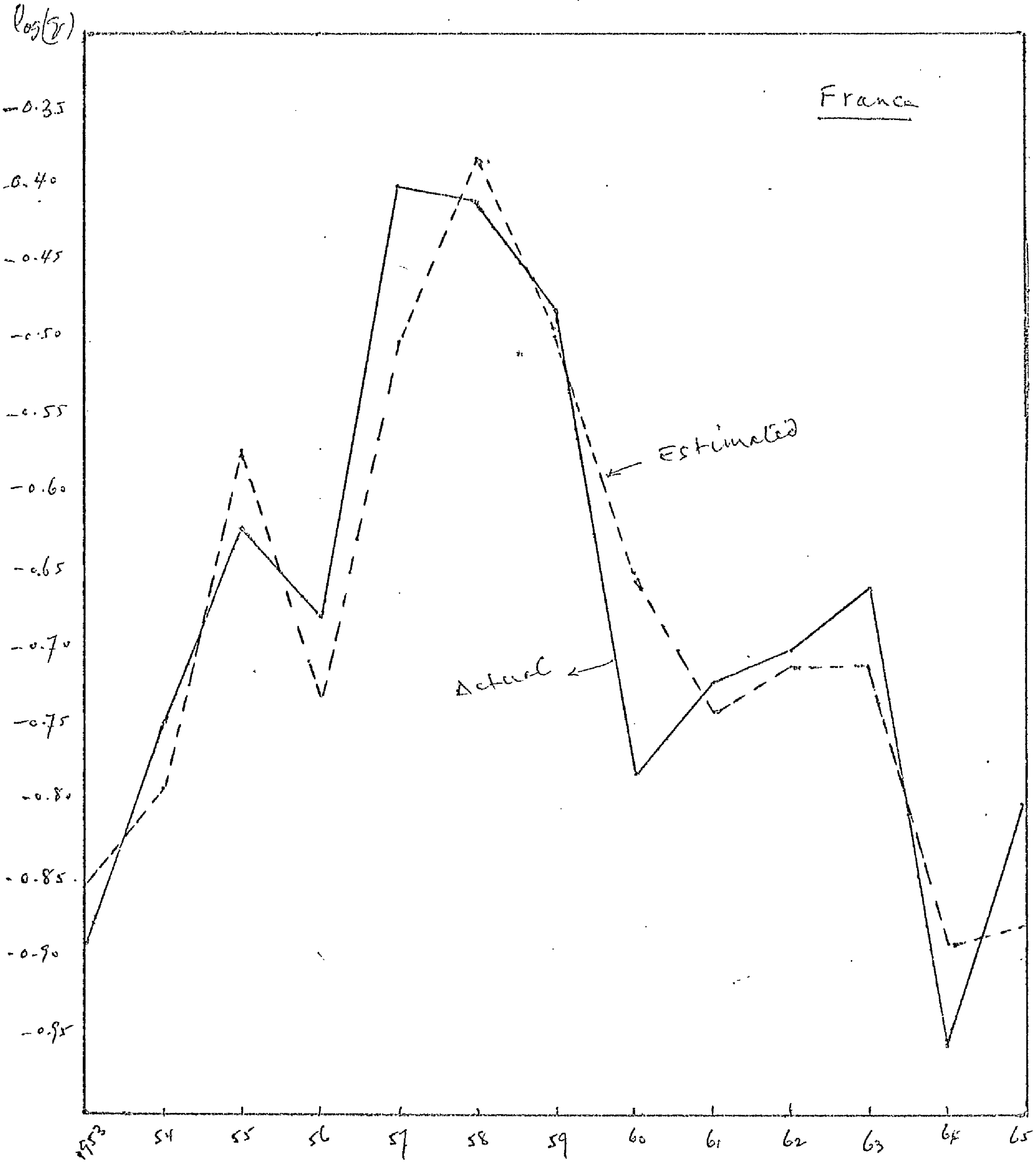
Equation (4.3.9) of table 4.13 before accounts for 71% of the variations in per capita imports of Sudan ELS. Cross price elasticity of American cotton (P_a) and rayon (P_r) are the only significant terms in the equation at the 5% level.

While rayon proved to be a keen substitute for Sudan ELS, American short staple cotton did not, as is suggested by the sign and magnitude of their cross elasticities.

Contrary to what is expected, there is no evidence from the analysis to suggest competition between Sudanese and Egyptain ELS in the French market. France, indeed, is a traditional market for Egyptian ELS cotton. French spinners use the Egyptian variety for 70 - 80% of their production while Peruvian and Sudanese together account for 10-15%.(1) This may indicate stronger competition between the last two varieties which share the residual in the French market.

Relative price $(\frac{P_s}{P_e})$ was used to overcome the intercorrelation between them (r = 0.947) but without gain. However, in only one equation of the many alternative combinations attempted, the price of Sudan ELS turned out to be significant and retained the right sign.

(1) I.B.R.D. ELS cotton, 1964, Appendix (2), p.22.



Chart(4.12) Actual vs. Estimated per Capita imports of Sudan ELS Cotton in France

Equation (4.3.14) (Appendix A) gave a price elasticity of (- 3.0393) significant at the 5% level; (P_s) together with ($\frac{P_s}{P_a}$) and (Y) explained 38% of the variation in (q) ($\bar{R}^2 = 0.38$).

In the same equation (4.3.14), a significant regression coefficient of income is obtained. It indicates a negative income elasticity of (- 2.1437) significant at 5%. Again this makes it difficult to conclude that Sudan ELS cotton is an inferior good in the French market.

The French textile industry is not without difficulties. It suffers from cyclical and structural difficulties.(1) Moreover the negative sign of income elasticity may be due to the small amount of France's income spent on purchases of Sudan ELS cotton. In such a case the whole group negative effects would counterweight the positive effects of the small group whose preferences are for ELS cotton of Sudan.(2) It is a statistical bias that emanates from the homogeneity assumption underlying the use of per capita income figures in the estimating equation.

(3) W. Germany

The German spinners have increased their purchase of Sudan ELS cotton. Unlike U.K. and France, Germany's share of Sudan ELS exports has been rising (table 4.7). As these purchases are made according to auction sale conditions of Sudan cotton, quantity and price movements are believed to reflect the forces determining the demand function.

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(1) Kuczynski, M. "1965 U.S. Cotton Policy", I.M.F. Staff Papers, 1966 (March), p. 70.

(2) Hicks, J. Value and Capital, 1939, p.34-35.

Equation (4.3.16) of table (4.13) explains 80% of the variation in the quantity demanded. It includes most of the variables which a priori are expected to influence the demand for ELS. Moreover their regression coefficients, i.e. respective elasticities, attain the conventional acceptable level of significance of 5%.

(3a) Price elasticity

The price regression coefficient is significant and shows the right sign at the 5% level. It indicates a high price elasticity of (- 6.85). This high elasticity confirms the increasing competition between the Sudanese ELS and the Egyptian ELS. The latter dominated the German market at a time when the Sudanese variety was bulk sold and concentrated in the U.K. market. With Sudan ELS's loss of the British market, penetration to the established markets of Egyptian ELS took place at very competitive prices.

(3b) Cross Elasticity

(i) Egyptian Cotton:

Germany's demand for Sudan ELS has a significant cross elasticity with the price of Egyptian cotton (P_e). It is as high compared with the price elasticity of Sudan cotton. The cross elasticity is (4.2279), significant at 5% thus confirming the keen competition between the two varieties of Egypt and Sudan ELS.

(ii) American cotton:

Its price regression coefficient did not show any sign of competition with Sudan ELS. However, it is significant at 5% and of a magnitude as high as (- 4.72).

The American cotton variety is a short staple cotton which primarily is not expected to compete with the ELS type. The competition is between the sources supplying ELS in the first place. Therefore, when American cotton price (P_a) and Egyptian cotton price (P_e) appear in one equation the latter is a priori expected to assume a crucial influence on the demand for the ELS variety of Sudan cotton. American cotton price is strongly positively correlated with two other independent variables in the same equation, price of rayon (P_r) and per capita income (Y) ($r = 0.8839$ and 0.8625 respectively). Though American cotton proved to be in competition with Sudan ELS in the German market, when their elasticity of substitution is estimated on relative quantity and price ratios (discussed at the end of this section), less attention is given to correcting the influence of multicolinearity referred to earlier in the demand equations (4.3.16) of Sudan ELS cotton. Emphasis is on crucial variables to which American cotton price (P_a) lost ground when they were confronted in one equation.(1)

(iii) Rayon price (P_r)

Rayon has a significant cross elasticity of (10.1156) with demand for Sudan ELS cotton in Germany. It is significant at 5% and has a sign which indicates that rayon is in keen competition with ELS, i.e. with a 1% increase in the price of rayon, other things held constant,

(1) Farrer and Glanber "Multicolinearity in Regression Analysis", R.E.S., 1967 (Feb.) p.106-107.

Germany's demand for ELS of Sudan will rise by 10%. In Western Europe, British and German spinners increasingly use industrial fibres. It is a fibre competition that can only be mitigated by a stable and competitive price of ELS cotton.

(3c) Income Elasticity:

Both regression coefficients of per capita income (Y) and index of textile production (x) are insignificant though retaining the expected positive sign. The explanation for the insignificant role of income in accounting for the variation in the demand for ELS of Sudan lies in the small proportion of income spent on this commodity. This makes the demand entirely dependent on the relative prices of the competing fibres (Sudanese, Egyptian, Rayon and American cotton), and the resulting elasticity of substitution among them. Another possibility can be sought in the high multicolinearity between income (Y) and other terms in the demand equation: (P_e), (P_r) ($r = 0.8625$ and 0.9051 respectively).

In an equation which includes the price of ELS (P_s), per capita consumption of synthetics (q_r) and per capita income (Y), the income variable has an income elasticity with the expected positive sign and is slightly short of the 5% significance level which it barely missed (equation No. 4.3.21, App. A). This estimate has not been chosen as it gives poorer fit and significance compared with that of the basic equation under analysis (4.3.16). It is the price variable which account for the greatest part of the variation in (q). And while income is statistically insignificant, it is kept in the estimating equation as it raises the value of $\bar{R}^2$.

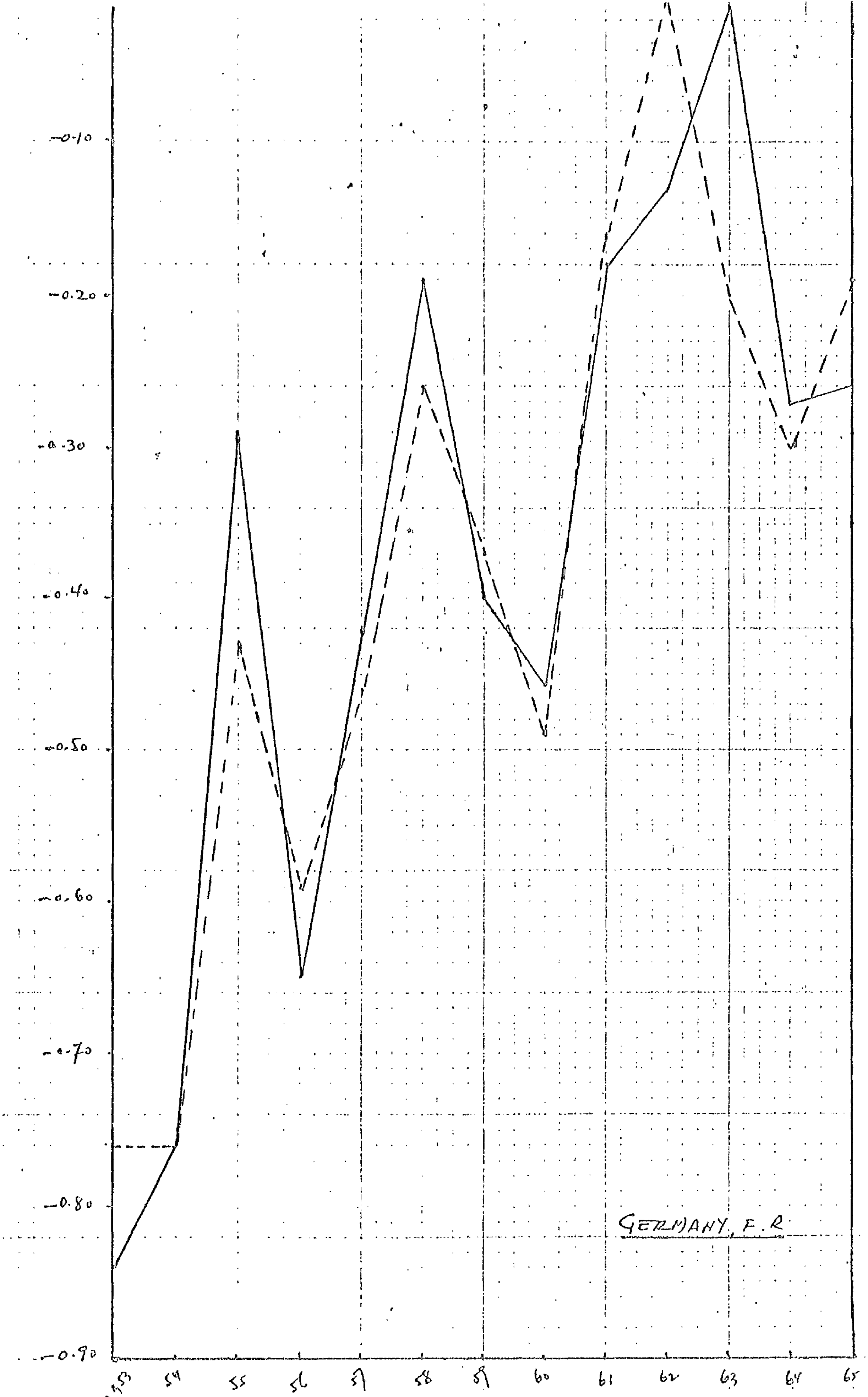

Chart (4.13) Actual vs. Estimated per capita imports of Sudan ELS Cotton in GERMANY, F.R.

(4) Italy

Prices of Sudan ELS (P_s) and Egyptian (P_e) explained 67% of the variation in Italy's demand for Sudan ELS cotton. They proved to be the most crucial and significant variables in determining the level of demand as follows:

(4a) Price Elasticity

From equation (4.3.22) (table 4.13 above) a very high price elasticity is obtained. It is significant at 1% and of a magnitude equal to (- 13.5). The Italian market is a traditional consumer of Egyptian cotton compared to the Sudanese. This high price elasticity reflects the degree of the Italian demand sensitivity to price changes of the Sudan variety. A 10% rise in price of Sudan ELS will depress the demand by 135%, other things being equal.

(4b) Cross Elasticity

(i) Egyptian price (P_e):

The regression coefficient of this price indicates a significant cross elasticity at 1% and equal to (12.03). Theoretically, on the assumption of perfect knowledge and rationality, the consumer is influenced by relative price changes in a way that makes both price elasticity and cross elasticity of the competing goods equal but with opposite signs. Depending on whether the consumer is more price conscious or less price conscious, the price elasticity of the commodity in question will be larger or smaller than the cross elasticity with the subsitutes.[1]

(1) Stone, R. "Analysis of Market Demand", J.R.S.S. 1945, p. 294-295.

In this context the Italian market demand for Sudan ELS is, to a great extent, determined by the relative price with the Egyptian. The price consciousness of this market is manifested by the larger magnitude of the Sudan price elasticity than the cross elasticity with the Egyptian price ($-13.5 > 12.03$). The significance of this estimate is reinforced by the fact that the Italians are traditional consumers of Egyptian cotton and that prices only account for variations in the demand functions.

(4c) American Short Staples and Rayon

The American cotton price (P_a) did not show any significant cross elasticity with demand for Sudan ELS cotton in Italy. In all the estimates attempted/its regression coefficient retained a sign that did not indicate the existence of competition between the two varieties.

Rayon, on the other hand, proved to be a substitute for ELS of Sudan in only one equation (4.3.25 Appendix A) of the fitted regressions. The coefficient of the relative price variable($\frac{P_s}{P_r}$) is significant at the 5% level and retains a sign confirming competition as (−3.7852). Equation (4.3.25) includes transformation of the variables, as relative prices, so as to mitigate the effect of multi-colinearity especially between (P_a) and (P_r) ($r = 0.8902$). Hence, the significant influence of rayon as a substitute was only here detected.

(4d) Income Elasticity

Though income (Y) and index of textile productions (x) did not play a major part in explaining the demand for ELS in Italy, they retain the expected positive sign. This was particularly so when

Chart (4.14) Actual vs. Estimated per Capita imports of Sudan ELS Cotton multicolinearity was reduced by dropping the highly correlated variables with (Y) or (x), or by using the transformations of these variables. (Equation 4.3.24 and the rest in Appendix A). However, the fit does not improve on that of the basic equation in table 4.13 above.

As income (Y) or (x) increase, the Italian market will demand more of Sudan ELS. But as the proportion of income spent on Sudan ELS is small, much of the variation in demand will be determined by the price elasticity which in this case is more related to the elasticity of substitution with Egyptian cotton than to income..

(5) India

Aggregate figures of India's imports of Sudan cotton (Q_s) and income (Y) were used instead of their per capita equivalents. However, the inclusion of the time variable in the basic and other equations in the Appendix, is believed to account for the population effect among the other systematic unspecified forces in the estimating equations.

India's demand function in table 4.13 above explained 71% of the variations in her demand for Sudan ELS cotton during the period of study. The characteristics of this demand function are discussed below.

(5a) Price elasticity

The price elasticity obtained for India's demand for ELS is significant at 5%. It is a relatively high elasticity (- 5.7).

(5b) Cross Elasticities:

A cross price elasticity of (3.5), significant at the 5% level, is obtained for Egyptian cotton. It indicates that both Sudan and Egypt ELS are in keen competition in the Indian market. The relatively high estimates of both its own price and cross elasticity with Egypt's price, suggest that the degree of competition is determined by their relative prices.

As for short staple cotton, Sudan ELS in India is not expected to be in competition with American cotton and the domestically grown Jarilla cotton. However, in the analysis, the price of Jarilla (P_j) was introduced and preferred to the American cotton price (P_a). The reason is that India obtains American cotton according to concessiona arrangements which involves no payments in foreign currency. Needless to say, India's foreign exchange position restrains the level and growth of her imports including Sudan cotton.

Unlike American cotton price (P_a), India's Jarilla fine cotton price (P_j) retains a positive regression coefficient though statistically non-significant. It refers to a tendency to substitution and competition with Sudan ELS (equation 4.3.35 Appendix A).

Finally competition with man-made fibres was traced by introducing India's total consumption of rayon piece goods (Q_r). The regression coefficient of this variable in the basic equation is significant at 10%, with a positive sign indicating that consumption of rayon does not create any reduction in India's demand for Sudan ELS cotton. Yet in equation (4.3.37 Appendix A) when income (Y) was dropped because of its intercorrelation[1] with (Q_r), the latter had a regression coefficient with a negative sign but statistically non-significant. Does this reflect any tendency to competition between rayon and Sudan ELS cotton in India?

The seriousness of competition between rayon or man-made fibres in general, and ELS cotton in India is a function of two factors: the level of income and climatic conditions. Both ELS cotton cloth and rayon are quality consumption goods which are determined and influenced by the level and distribution of income. The moisture absorbancy characteristic of cotton is an advantage which rayon or synthetics generally lack. As research is highly concerned with developing this missing quality in man-made fibres, the only factor that will determine the degree of competition with ELS cotton in future will be the price differential. In this respect the man-made fibres'industry provides a big potential for cost reduction. At present, ELS cotton in India is believed to face a slight threat from synthetics in general.

(5c) Income elasticity

From equation (4.3.31) table 4.13 above, India's imports of Sudan ELS cotton showed an inverse relation with income (Y). Instead, the index of cotton textile productions (x) was introduced into the estimating equation. It had a regression coefficient with a positive sign though statistically non-significant (equation 4.3.36 Appendix A). Moreover, in none of the fitted regression equations did the time variable have a significant coefficient.

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(1) $r = 0.8$

The effects of the index of cotton textile production (x) and the time variables, together with the following reasons, make it difficult to accept the inverse relation between India's income and her demand for Sudan ELS cotton which would mean that ELS cotton is an inferior good:

(i) The demand for cotton cloth in India is income elastic. It is well above unity.(1) Without knowing the details and coverage of this estimate one can safely say that the income elasticity for fine cotton textiles, made of ELS, will be much greater than the one established for cotton textiles in general. As the demand for raw cotton is a derived demand, the income elasticity of the demand for raw ELS cotton of Sudan in India would be less than that for fine cotton textile (i.e. a direct and positive relationship is expected to exist between India's demand for ELS cotton and her income).

(ii) Both aggregate income and per capita income figures were introduced into the regressions and both have the same results of a negative regression coefficient with Indian demand for Sudan ELS. In both cases the small proportion of income spent on Sudan cotton and the impact of the pattern of income distribution may not allow a significant result accepted on *a priori* assumption of positive income elasticity. This was confirmed when the index of cotton textile production was used as an alternative to income. Though (x) did not yield a statistically significant coefficient, it retained the expected sign indicating that with increasing cotton textile output, more of Sudan ELS will be required.

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(1) Quoted in Singh's *India's Exports*, p. 95.

(iii) The unsatisfactory conditions of the Indian cotton textile industry during the period of study, in particular the performance of her exports.

Cotton textiles in India is an important manufacturing sector in the economy. It is a main source of foreign exchange. During the last decade its contribution amounted to 10 - 13% of total export receipts.[1]

In his study of India's exports, Singh argues that India failed to increase her share in world trade of cotton textiles during 1950-1960 despite the relative fall in the share of the major exporters, (U.S. and U.K.). The advantage of this was taken by Japan which succeeded in raising her (volume) exports by 82.5% between 1948-50 and 1958-60. This is shown in table 4.16 below though in relative shares rather than absolute volume.

India's declining export trend of cotton textiles continued beyond Singh's study period up to 1960. This is seen from the table below for the added years 1961,2,3.

The reasons to which Singh attributes the export decline are summarized as follows:

(1) Modest expansion of the international cotton textile trade. This slight increase was due to movement of textiles between the net exporting countries of Western Europe (U.K., U.S.A.) and Asian countries. It was a result of some liberalisation of the textile trade and fewer restrictions on imports.

(2) Growth of competition from other industrial fibre textiles (see table 4.1 before).

(1) Ibid. p. 72.

Table (4.16) Exports of Cotton textiles (Tissues, Yarns and other manufactured) by India, Japan, U.K., U.S.A. and Others 1948-50 - 1963

(per cent) shares

Country	1948-50 ann. av.	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
India	11.3	10.5	10.1	10.8	13.4	10.4	10.7	11.9	10.5	11.6	8.3	6.7	6.8	7
Japan	11.3	13.2	12.6	14.4	17.3	16.9	17.1	18.7	17.9	16.3	18.1	16.7	17	15.4
U.K.	17.7	15.7	14.4	15.0	13.1	12.3	10.6	9.8	9.1	7.3	5.0	5.2	4.5	4
U.S.A.	15.0	13.4	13.7	12.1	10.8	10.1	9.2	9.5	9.2	7.4	6.2	6.8	6.0	6.3
Others		48.2	49.2	47.7	45.4	50.3	52.4	50.1	53.3	57.4	62.4	64.6	65.7	67.3
World		100	100	100	100	100	100	100	100	100	100	100	100	100

Source: (1) up to 1960 from Singh's study table V.1, p. 74.
(2) 1961 - 63 from F.A.O. World Apparel Fibres Consumption, Rome, 1965.

(3) More important is the impact of import substitution policies followed in most of the net importing countries (developing countries). This group of countries thus curtailed their imports from traditional sources by processing some of their domestically produced cotton. The special significance of this on India's exports is due to her concentration on the coarse grey cotton cloth which can be easily produced without the need for great skill in the newly established cotton textile industries.

(4) the foregoing were external causes, yet there are internal factors to explain India's textile exports position.

(a) Evidence suggests increasing costs of production thus reducing India's competitiveness with other countries especially Japan. This was attributed to higher raw cotton prices, and higher wages in relation to levels of productivity when compared with those of Japan.

(b) Slow modernization of the industry and use of automated looms which produce according to the preference of consumers. Quality and standards have not improved and concentration on coarse and medium cloth with less up to date designs gave Japan the advantage in the export market. The Japanese textile industry is fully modernized and with imporved quality products.

(c) Growth of home sales. Producers unable to increase their exports due to the previously mentioned causes, turned to the home market which could be satisfied with the type of production which found it difficult to cope with foreign demand and competition. The rising domestic demand made the home market more profitable for producers than looking for export outlets.

However, India is a potential source of increasing demand for raw cotton from foreign suppliers. She is a net importer of raw cotton as the local production does not meet the requirements of the textile industry. The expansion of domestic cotton production is limited by the competition between food and cash crops for land.

India's demand for ELS of Sudan depends upon a host of factors. The increase of India cotton textile exports means overcoming the internal difficulties in quality of cloth and cost aspect that make the exports more competitive with others. Besides, trade barriers by the developed coutries against cheap and competitive imports of textile products should be removed. On the other hand, the concessional arrangements via which India obtains U.S.A. cotton is an unfavourable condition for the growth of other ELS imports to India which are subject to the stringent foreign exchange factor. Maybe better and thorough study of the Sudanese and Indian economies will favour a bilateral trade[1] agreement that eases the payments problems and promotes the imports of both countries. At present the Sudan ELS position in India is determined by maintaining a competitive price especially with Egypt's variety. Indeed India has been the second largest traditional importer of Sudan cotton and at present almost occupies the first place though her relative share has been slightly on the decline (table 4

(1) A previously concluded agreement resulted in a lop-sided a/c in favour of Sudan which failed to import Indian goods to the level of cotton exports (no reference is available at the time of writing). The main reason is the development of the Sudan textile industry which reduced considerably Sudan's imports of India's textiles (grey cloth).

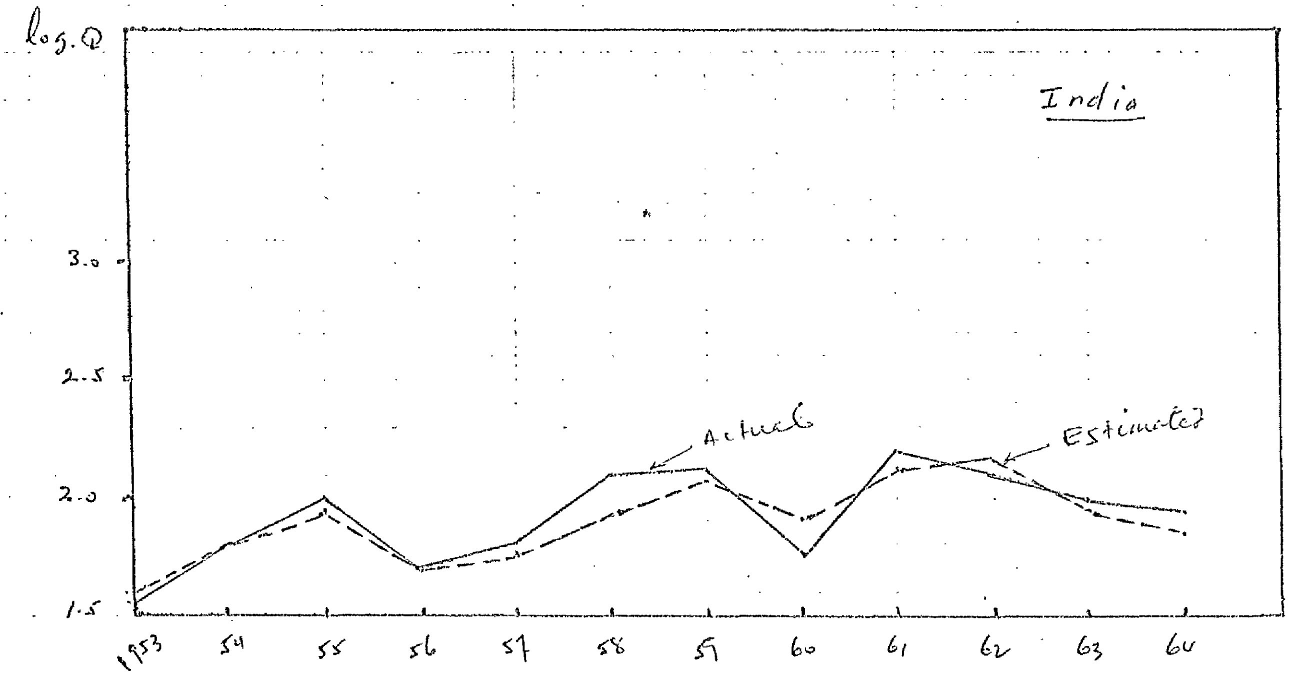

Chart (4.15): Actual vs. Estimated ELS Cotton of Sudan imported to India

(iv) ELASTICITY OF SUBSTITUTION FOR SUDAN COTTON: Relative quantity-price approach

Elasticity of substitution is defined in terms of market share of a country's imports in a certain market. This measure is based on changes in relative quantities of the competing imports as a result of a change in their relative prices. It was therefore originally used to test the working of price mechanism in the international market.

The reasons for applying this method to Sudan ELS cotton is the relevance of the issues and conditions involved in this approach. These are:

(1) Sudan ELS is a homogeneous commodity with those sharing its export markets. However, the homogeneity varies within the broad category of cotton fibres.

(2) Both Sudan and Egypt ELS are closely homogeneous and marketed in a rather oligopolistic condition (Sudan and Egypt export 80 - 85%).

(3) Difficulties facing export expansion, balance of payments difficulties and ensuing problems of trade policy and currency devaluation.

(4) Finally testing the underlying hypothesis and comparing the results with those of the direct demand function approach discussed earlier.

Estimates and Results

The elasticity of substitution (E_s) is calculated for the Sudanese ELS with the Egyptian ELS and American short staple cotton in the previously selected export markets of Sudan cotton. The results are summarized in tables (4.17) and (4.18) below.

Table (4.17) <u>Elasticity of Substitution: Sudan/Egypt ELS cotton In Selected export markets</u>

<u>1953-1965</u>

Eq. No.	Market	Period	Equation fitted	$\bar{R}$	$\frac{\delta^2}{S^2}$
4.4.1	France	1953-1965	$\log\left(\frac{q_s}{q_e}\right) = -0.4564 + \underset{(2.4408)}{6.2598^{*}} \log\left(\frac{P_s}{P_e}\right) + \underset{(0.0436)}{0.0827^{**}}\, t$	0.59	2.159
4.4.4.	W. Germany	"	$\log\left(\frac{q_s}{q_e}\right) = -48.6351 + \underset{(1.7205)}{3.6365^{*}} \log\left(\frac{P_s}{P_e}\right) + \underset{(4.7499)}{14.9099^{*}} \log Y \underset{(0.27357)}{-0.73194^{*}}\, t$	0.75	1.652
4.4.8	Italy	"	$\log\left(\frac{q_s}{q_e}\right) = -5.2323 - \underset{(2.9598)}{7.5202^{*}} \log\left(\frac{P_s}{P_e}\right) + \underset{(0.8101)}{1.9763^{**}} \log Y$	0.71	1.987
4.4.11	India	1953-1964	$\log\left(\frac{Q_s}{Q_e}\right) = -0.2235 + \underset{(2.4616)}{1.2609} \log\left(\frac{P_s}{P_e}\right) + \underset{(0.04724)}{0.07931}\, t$	0.28	1.471

* significant at 5% level

** significant at 10% level

All $\frac{\delta^2}{S^2}$ show no evidence of autocorrelation at 5% level of significance.

In all the equations, the relative prices regression coefficient is the elasticity of substitution (E_s). First, the elasticity of substitution with Egyptian cotton will be discussed.

(a) ELS Sudan/Egypt:

The Egyptian is the keenest competitor with Sudan cotton. Both belong to ELS. However, this assumption ignores the established name of the Egyptian variety in the markets studied and further assumes the perfect knowledge and awareness of the Sudanese ELS as a perfect substitute for the Egyptian.

From table (4.17), out of the four markets studied, only in Italy does the price variable retain the right (negative) sign indicating substitutability. In the other cases, France W. Germany and India, the price coefficient has a positive sign which is not *a priori* expected.

However, of all the estimates, the elasticity of substitution is only significant in the case of Italy. It is a very high elasticity of substitution (-7.5), significant at the 5% level. This means that any increase in relative prices will be rapidly against the share of Sudan[1] in the Italian market.

The significance of the income variable in Italy's equation indicates that with rising income the share of Sudan ELS cotton relative to the quantity of Egyptian ELS will be increasing. Most important, this result would imply that the income elasticity

(1) Morrissett, J. "Some Recent uses of Elasticity Substitution" Econometrica 1953, p.54.

of the two countries' ELS cotton in Italy is not equal and the differential income effects are in favour of the Sudanese. Moreover, the trend variable in equation (4.4.10 Appendix A) is significant and indicates that during the period of study the relative quantity changes $(\frac{q_s}{q_e})$ have been in favour of the Sudanese at an annual rate of increase of 11%.

France, W. Germany and India, on the other hand, have an unexpected elasticity of substitution a priori. The relative price $(\frac{P_s}{P_e})$ regression coefficient retains the wrong sign i.e. positive and is greater than zero. The a priori expected result suggested by economic theory, is that the elasticity of substitution between the two competing goods should take some value between (0 and $-\infty$). If the regression coefficient of relative price i.e. elasticity of substitution, is equal to zero, changes in market share will be directly proportional to price ratio. When the latter is a positive value, changes in relative price will result in a more than proportional change in market share.(1)

Comparing the results obtained here according to the relative quantity-price approach with those of the direct and single equation approach one would find the following: only in Italy's case do the results of the two approaches agree as expected a priori. They both refer to the fact that the Sudanese and Egyptian ELS cotton are in relatively keen competition. Both the elasticity of substitution and the cross elasticity estimates are statistically significant, greater than zero and a priori expected.

(1) Ibid., p. 54.

In the French market, the failure to obtain a result for the elasticity of substitution comparable with the Italian's, is a confirmation of the earlier result given by the direct demand function approach. According to the latter the price of the Egyptian cotton (P_e) did not turn up in any of France's demand equations as a significant explanatory variable. Hence, no significant price cross elasticity with Sudan cotton is found. This means that prices are not a strong determinant of ELS market share in France. The relative significance of the trend variable in table (4.17) indicates that there may be some other variables, concealed under it, which when specified would account for the changes in the relative quantity $(\frac{q_s}{q_e})$ and the respective market shares of ELS.

The last two cases of W. Germany and India are more interesting. While in both markets a significant estimate was obtained for the cross price elasticity of the Egyptian cotton with the quantity demanded of the Sudanese, no such evidence for keen competition was manifested by the elasticity of substitution approach. The estimates of the elasticities of substitution in both markets are not expected a priori i.e. movement of relative quantities $(\frac{q_s}{q_e})$ is not in inverse relation with movement in their price ratio $(\frac{P_s}{P_e})$ as suggested by hypothesis of economic theory. However part of this controversy can be explained as follows: the quality of the data used may not yield the type of result a priori expected for the elasticity of substitution between Sudan and Egypt's ELS cotton. Relative quantities and prices might not have moved in a way that would reflect substitutability and keen competition. If this was allowed to take place in a way and frequency sizable enough, the underlying assumptions of the relative quantity-price approach would have been substantiated. That is to say, evidence would have been obtained, through estimates of the elasticity of substitution of the working of price mechanism.

During the period of study, Sudan's economic relations with W. Germany have been rapidly increasing. Loans and participation of W. Germany's capital found their way to the Sudanese economy. The influence of this can be easily identified with most of Sudan's key projects undertaken during the period of study (e.g. Rosieres Dam, Sugar factories, Managil Main Canal etc.). This, together with a relative shortage of Egyptian cotton, due to its disappearance from the western markets and its redirection to the eastern bloc, is liable to influence the resulting time series of the respective purchases and prices of ELS cotton.

Similar, but more explicit forces, provide an explanation for India's case. Egypt, during the period of study 1953-1965; has operated bilateral trade and payments agreements with India. The most significant one is that of 1953 which was readjusted in 1956 to cope with the resulting situation of the Suez crisis and the blockade of her sterling balances in U.K. Accordingly, the change in the bilateral agreement with India was to the effect that all payments were to be made in Indian rupees. Meanwhile, a 70 million rupee credit was made available to Egypt to finance, mainly, exports of long staple cotton and imports of tea and jute.[1] This would, undoubtedly, affect the quality of data used as it breaks the connection between market conditions and transactions concluded.

(b) <u>Sudan ELS/American cotton</u>:

ELS cotton and American short staple are not very homogeneous goods. However, they are both within the broad classification of the single commodity: cotton. Generally in such situations a low elasticity of substitution is expected as the goods are not in direct and strong competition.

At present, the elasticity of substitution has been increasing with the development of textile machinery, the price differential of the two qualities and the growing use of short staples in blending with synthetic fibres.

In the four markets studied, in table (4.18) the elasticity of substitution maintained the right expected sign of substitutabili between both fibres and their share was affected by changes in relative price $(\frac{P_s}{P_a})$.

For U.K. and W. Germany the elasticity of substitution is significant at the 10% and 5% levels respectively. Any increase in the relative price $(\frac{P_s}{P_a})$ will act against the Sudanese share in both markets.

The important thing to notice is the significant elasticity of substitution between Sudan ELS and American cotton in W. Germany. In the single demand equation (table 4.13) of Sudan

(1) E.C. Africa document on <u>African Countries Bilateral Agreement</u>, E/CN. 14/STC/24/Rev. p. 46 and Annex p.58.

Table (4.18) Elasticity of Substitution: Sudan ELS/American short staple cotton in Selected export markets

1953-1965

Eq. No.	Market	Period	Equation fitted	$\bar{R}$	$\frac{\delta^2}{S^2}$
4.4.14	U.K.	1953-1965	$\log\left(\frac{q_s}{q_a}\right) = -0.0607 - \underset{(0.8626)}{\overset{**}{1.6928}} \log\left(\frac{P_s}{P_a}\right)$	0.44	3.122
4.4.18	France	"	$\log\left(\frac{q_s}{q_a}\right) = -5.9001 - \underset{(1.1185)}{0.9897} \log\left(\frac{P_s}{P_a}\right) + \underset{(1.0074)}{1.4392} \log Y$	0.20	1.569
4.4.22	W. Germany	"	$\log\left(\frac{q_s}{q_a}\right) = -11.2639 - \underset{(1.6373)}{\overset{*}{3.7508}} \log\left(\frac{P_s}{P_a}\right) + \underset{(1.2034)}{\overset{*}{3.3176}} \log Y$	0.670	2.328
4.4.25	Italy	"	$\log\left(\frac{q_s}{q_a}\right) = 76.1887 - \underset{(2.2791)}{1.9194} \log\left(\frac{P_s}{P_a}\right) \underset{(16.9528)}{\overset{**}{-32.9530}} \log Y + \underset{(0.9997)}{\overset{**}{2.0603}}\, t$	0.42	2.405

* significant at 5% level

** significant at 10% level

All $\frac{\delta^2}{S^2}$ show no evidence of autocorrelation at 5% level.

cotton in Germany, the cross elasticity with the price of the American (P_a) indicated that there is no competition between the fibres. This discrepancy is not a real one. It is due to the high multicolinearity between the variables in the demand equations referred to before (see page 82). American cotton price degenerates as an influential variable in the presence of more crucial explanatory variables in the relations. Here, there is no intercorrelation between income and American price, as the latter is transformed as $(\frac{P_s}{P_a})$, with no other important variables in the relation. Hence the full impact is detected.

However, the fact remains that the market share of Sudan ELS in W. Germany depends upon its relative price $(\frac{P_s}{P_a})$ and especially that it is favoured by the income elasticity. The latter is significant at 5% and indicates that the assumption of equal income elasticities for American and Sudan cotton is not valid.

The poor fit obtained for France and Italy indicates that there is a low substitutability between Sudan ELS and American cotton. And the response of market shares to relative price change will be very slow.

(v) Elasticity of Substitution vs Cross Elasticity

This is a point often discussed when demand functions are derived for internationally traded commodities, such as cotton.

Cross elasticity is defined as the partial derivation of the quantity of the good in question with respect to the prices of the other good (substitute or complementary) included in the demand functions.

Elasticity of substitution on the other hand is defined in terms of the change in the relative quantity demanded of two goods as a result of a change in their relative prices. The measurement of this elasticity is taken as an indication of the working of the price mechanism in international trade. Therefore the definition of the concept is made in terms of market shares resulting from the movement of the relative quantities in the particular market as determined by their relative prices.

The concept originally was used in the theory of production where substitution between two factors of production is determined by their marginal productivities.(1) If the two factors are (X_1) and (X_2), the elasticity of substitution (E_s) is as follows:

$$E_s = \frac{d(X_1/X_2)}{d(dX_2/dX_1)} \quad \frac{(dX_2/dX_1)}{(X_1/X_2)} \quad (1)$$ which in terms of logarth. become

$$E_s = \frac{d\log (X_1/X_2)}{d\log (dX_2/dX_1)} \qquad (2)$$

At the position of a competitive equilibrium the ratio of marginal productivities is equal to the ratio of the respective prices:

$$\frac{dX_1}{dX_2} = -\frac{P_1}{P_2} \qquad (3)$$

Substituting (3) in equation (2) we get by taking all in logarth:

$$E_s = \frac{d\log (X_1/X_2)}{d\log (P_1/P_2)} \qquad (4)$$

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(1) Morrissett, I. "Some recent uses of Elasticity of Substitution A survey", <u>Econometrica</u> 1953, Vol. (21) p. 41-61.

The same definitions can be derived when applied to demand theory instead of the theory of production. By assuming (X_1) and (X_2) as two commodities, the elasticity of substitution is determined by their marginal rate of substitution. In equilibrium the ratio of marginal utilities is equal to the ratio of the respective prices. For utility to remain constant, changes in either of the two commodities must be offset by changes in consumption of the other.

The estimate of elasticity of substitution by the previous definition has been attacked by many critics who question the practibility of the measure in framing trade policies.

The first criticism is to the effect that the estimate (E_s) is based on the assumption that relative price is the only variable determining the relation. This is a restrictive condition and can only be acceptable if the change in the relative quantity demanded (market share) with respect to other goods' prices and income is equal to zero. That is to say, if both (X_1) and (X_2) have equal income elasticity as well as equal cross elasticities with respect to other goods.

Secondly the estimate (E_s) is criticised as not being a pure measure of substitution elasticity caused only by demand factors. Other influences of supply factors are incorporated in it. This criticism suggested the use of a simultaneous equation approach as first attempted by Morgan and Correlete(1) though without significant improvement on what has been obtained by the single equation approach

(1) Morgan & Correlett "The influence of Price in International Trade: A Study in Method" J.R.S.S. 1951 (A114) Part III, p. 307.

of demand function. In fact prices of export commodities are largely determined by domestic factors (supply) and interplay of world conditions. As the importing country has no influence in affecting the price the estimate (E_s) will be due to pure demand elasticity.[1]

Stern and Zupnick[2] make their critique on the ground that the elasticity of substitution is of doubtful significance from economic theory point of view (vs. the statistically based criticisms mentioned above). They maintain that the snag concerns the price differential which determines the movement of the market to a new equilibrium position with new sharing ratio of the traded commodities. They extend this criticism to both homogeneous traded goods as well as heterogeneous ones. For the latter the case is obvious as there is no one representative price that can be reliably quoted. While the condition of homogeneity is necessary it is not a sufficient one. The reason, in their view, is the difficulty in specifying and dating the initial disturbance and the consequent market adjustment so as to evaluate the difference between true and computed elasticity.

The concept and measurement[3] of the elasticity of substitution attracts a lot of concern in international trade. It is believed that it is of practical relevance to trade policy and the ensuing issues of devaluation and balance of payments problems. Therefore,

(1) Prais, J. "Econometric research in International Trade: A Review", Kyklos 1962, (Vol. 15).

(2) Stern and Zupnick "The Theory and Measurement of Elasticity of Substitution in International Trade" Kyklos Vol. 15, 1962, p. 561 and p. 589 respectively.

(3) Tinbergen, Chang, Polak Review of Economic and Statistics, 1946, 1948, 1950 respectively. More recent ones are given in Prais and Stern studies referred to earlier.

the coverage of the many studies made, ranged from the whole packet of exports to individual homogeneous commodities selected for their importance in the international trade of the country in question.

However, the meaningfulness of the estimate (E_s) based on the relative quantity-price ratio of the internationally traded commodities depends very much on the nature and adequacy of data and the characteristics of commodities and their markets. The nature of the market (perfectly competitive, monopolistic or oligopolistic) determines to a large extent the magnitude and direction of the price movement and the degree of independence in choosing the price.

Because of such statistical and theoretical doubts surrounding the elasticity of substitution estimate based on the relative quantity-price ratio, the cross elasticity is generally preferred. The cross elasticity is obtained from explicitly included prices of other goods in the conventional single demand function. It indicates (%) magnitude of change in the quantity demanded as a result of a given change in the price of the substitute. The cross elasticity coefficient is "really the definition of elasticity of substitution in disguise and thus <u>pertains to relative</u> quantity change, not <u>an absolute rise</u> in one and absolute decline in the other".(1) If the cross price elasticity is zero it means that the price elasticities are equal to each other and both are equal to elasticity of substitution.

The cross elasticity is certainly more revealing than the single estimate of elasticity of substitution discussed before. The latter is seen as a composite estimate concealing all the factors influencing the relation and not explicitly specified and introduced in the estimating equation.

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(1) Preeg, E.G. "A Comment", Kyklos, 1963, Vol. (16) p. 668.

(vi) Price elasticity vs. Price flexibility:

It is the relation between the price and the quantity demanded when price is taken as the dependent variable. It is the reciprocal of price elasticity.

The need to consider this contrast between price elasticity and price flexibility as an aspect of demand analysis is to seek an answer to the question: which to take as the dependent variable: price or quantity?

Generally in a market situation the quantity demanded is taken as the dependent variable on the assumption that all the variables on the right hand side of the equation including the price of the commodity are predetermined, i.e. only quantity is subject to variation. These are considered the independent variables which would explain the variation in the quantity demanded. In this case the relation between quantity and price is defined as the price elasticity.

In agricultural economics the quantity supplied to the market is largely determined once the operation of sowing is accomplished. The quantity of output is henceforward subject to weather conditions and the amount of productivity of the inputs already committed. That is to say, the supply is inelastic and independent of the price of the current period.

Price in such conditions will be subject to variations, depending on the size of the crop realized at harvest time and the quantity available to the market. The relation between price and quantity is then known as the price flexibility.

The relation between price elasticity and price flexibility is largely determined by the relation between cross elasticity with other goods and the good in question. It is only when cross elasticities with other goods are equal to zero that price flexibility of a commodity equals the reciprocal of its direct price elasticity.

While price flexibility is the reciprocal of the price elasticity, the opposite is not necessarily the same. The reciprocal of price flexibility, depending on the cross effects with other commodities, is absolutely less than the true price elasticity. Therefore it is always preferable to derive each separately rather than to infer them from one single estimate.(1)

Depending on which is required; nature of demand schedule (price-quantity) or intensity of demand (quantity-price), the estimate can be made. Such a distinction is by no means mutually exclusive as economists and policy makers are always concerned with both the nature and shift of the product demand curve.

The relevance of discussing price flexibility vis. price elasticity to the Sudan cotton trade in question is determined by her position in the world trade of extra-long staple cotton. Sudan is not the leading producer that sets the price of ELS cotton in the market. Thus an estimate of price flexibility does not matter or help in policy decisions as do estimates of price elasticities of demand. On the other hand, Egypt is the largest producer of Sudan's variety of ELS cotton (50%+). The size of her crop and its supply in the market

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(1) Houck, J.P. "The relationship of direct price flexibility to direct price elasticity", J.F.E. 1965, Vol. 47 (1), p. 790.

together with interplay of world conditions dominates the course of price in any current year. Sudan can not ignore Egypt's price when pricing her cotton crop. This is a reasonable hypothesis which will be tested when price formation of Sudan ELS cotton is analysed in Chapter VI later.

However, an important fact to remember is that since the mid-50's the phenomena of increasing stocks of cotton does not leave much room for the influence of inelasticity of supply discussed earlier. Stocks definitely increase the elasticity of supply which can accommodate a rise in demand. For all this the importance of the price elasticity estimate (intensity and shift of demand) needs no emphasis and is more suggestive.

CONCLUSIONS:

(1) Cotton as an apparel fibre has been declining in relation to total consumption of textile fibres, though in absolute terms it has been increasing. Most of the decline in cotton's share is taken by man-made fibres. From empirical demand functions for consumption of all types of cotton, attempted by the present study in the selected markets (U.K., France, W. Germany, Italy and India), an inelastic demand to price was obtained. For the first three markets of Western Europe, the level of income, index of textile production and competition

from synthetics together with cotton price explained most of the variation in cotton consumption. The declining trend (negative and significant time variable) and the negative income effects point to the fact that, in these countries, cotton is no longer a non-inferior industrial raw material. With rising income less and less will be demanded and consumed.

In the remaining countries, Italy and India, the situation is different. The income effects or index of textile production are still in favour of cotton consumption.

On the whole, the factors at work influencing the consumption of cotton are: changing preferences, growth of competition from industrial fibres, the structural difficulties of the textile industry in U.K. and France and the resulting changing location of the cotton textile industries to the cheap labour regions coupled with the ensuing problems of trade liberalization in the world export markets.

(2) The world demand for ELS cotton has a price elasticity of about (- 0.8373). It is an inelastic demand, though much less inelastic than that for all types of cotton in the individual markets studied. When the relative price of ELS cotton to short staple $(\frac{P_{els}}{P_a})$ is used, a cross elasticity greater than unity is obtained (- 1.1).

World ELS cotton demand has a positive elasticity with indices of textile and manufacturing production, though less than one.

Most important is the significance of the results (both elasticities of price and level of activity) in the case of the traditional world markets of Western Europe. The latter is arbitrary defined for purpose of analysis as World excluding communist countries. It is the relative price $(\frac{P_{els}}{P_a})$ rather than the absolute price of ELS in Western Europe that considerably influences the level of ELS demand.

Less evidence is obtained for keen competition between ELS and consumption of man-made fibres on the World level.

(3) Sudan has been trying hard, during the period of the present study, 1953-1965, to redirect her cotton trade and increase her market share. This has been tried at very competitive prices and sometimes by bilateral agreements. Among other reasons, this is mainly the outcome of Sudan's geographic concentration of her cotton in the U.K. market, which with the dwindling of the Lancashire textile industry, became more noticeable.

The empirical analysis of Sudan ELS cotton demand suggests the following: apart from the previously major traditional market (U.K.), the price elasticity of the demand for Sudan ELS cotton is relatively high. It is considerably so in Italy, W. Germany, to a lesser extent in India and France. Their magnitudes are: (- 13.5), (- 6.85), (- 5.7) and (- 3.0) respectively.

(4) These price elasticities, together with the significant and relatively high estimates obtained for cross price elasticities with the price of Egypt's ELS cotton (except in the French market), indicate that there is a high degree of substitutability and keen competition between the ELS export shares of both Sudan and Egypt.

(5) When attempting the estimates of the elasticity of substitution, between ELS of Sudan and the competing cotton of Egypt (ELS) and America (short staple), according to the relative quantity-price approach in the markets studied, the results were less significant and

in full agreement with those obtained by the direct single equation mentioned in (4) above. It was only in the case of Italy that both the results of the direct cross elasticity and the elasticity of substitution tallied to the effect of a relatively high degree of competition and substitutability between Sudan and Egypt ELS cotton. Tendencies for substitutability were found between Sudan ELS and American cotton but again this was strongly manifested in W. Germany and to a lesser degree in the U.K. market.

(6) In all the individual markets of Western Europe, the study traced a significant competition between Sudan ELS and man-made fibres. This was of a marked significance in U.K. and W. Germany and relatively less in France and Italy.

Chapter Five

Supply and Production of ELS Cotton

Having examined the demand for ELS cotton in the previous chapter, it seems appropriate to study the supply side which is no less important in influencing price and incomes of cotton.

The study of supply deals with two basic relationships:

(a) Supply response i.e. a behaviouristic relationship showing how producers react to economic indicators and relative prices.

(b) Production function, a technical relationship of how resources at hand are combined and used in the activity in question.

However both supply and production functions are interrelated as the nature of the supply function rests on the nature of the production function.(1) In other words the supply function depends on the factor-cost-price ratio and the production function constraints. It becomes therefore essential to study both relationships if a complete account of the supply side of the cotton industry is required.

This chapter is divided into three sections covering: data used, supply response relation and production function of ELS cotton, respectively.

I Data Sources and Limitations

The empirical analysis of supply side is based on time series data for the period 1945/46 to 1963/64. In what follows, the variables related to the study of cotton supply are described together with their sources. Some of the data was collected from sources available in U.K., while the rest was compiled by the writer on his visit to Sudan in the autumn of 1966.

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(1) Heady and Dillon, Agricultural Production Functions, 1961, p. 1

Cotton output (Y, Y^1, Y^{11})

This is the dependent variable in production analysis. The three quoted variable (Y, Y^1 and Y^{11}) stand for ELS cotton output in the Gezira scheme, all Sudan ELS cotton sector and the private estates respectively. Output is measured in physical units of (000's) tons of total unginned ELS cotton every crop year. (The series related to these variables were quoted in the Agricultural Statistical Bulletin of the Ministry of Agriculture, Sudan 1963/64 and 1964).

Cotton price (P)

Cotton price is an annual average expressed in U.S. cents per pound of lint cotton at Liverpool cotton exchange. The series is derived from two sources:

(i) From 1945 to 1950, cotton price quotations were taken from Internal Statistical reports (Department of Statistics, Sudan). Originally these quotations were reported for the Egyptian variety 'Karnak'. It was taken as a proxy for the Sudanese variety 'Sakel'. As these prices were expressed in pence lb., they were converted into U.S. cents according to exchange rates prevailing and reported in the U.N. monthly bulletin of Statistics 1947/48. Use of the official exchange rate is not without shortcomings. Ideally a purchasing power parity exchange rate would have been appropriate yet this would involve more theoretical problems.

(ii) Between 1950/51 and 1963/64 cotton prices were quoted from the International Cotton Advisory Committee Bulletin (I.C.A.C.).

The price series thus constructed was deflated by the wholesale price index of all goods (1953 = 100). As the price series will be used in the study of supply response the inclusion of export taxes in some of the price observations quoted at Liverpool would influence the estimate attempted to detect the response of the growers of cotton to the price they receive.

Tenants profit share (R)

This is an explanatory variable used in the present study to trace out the tenants' response to economic incentive. The variable is suggested by the institutional organization of cotton where the price influence is believed to be negligible on the tenants. They are not in direct contact with market price in a way that would allow them to adjust their inputs, areas, crops. They can only change the effort they put into cotton. The variable therefore represents the share of profit accruing to them from cotton production. It is only attempted in the Gezira scheme where data is more readily available than in the other divisions of the ELS cotton sector. The tenants' profit share (R) is derived from Gezira Board annual statements of accounts. The series is deflated by the wholesale price index of food, drink and tobacco as there is no cost of living index pertaining to the tenants' locality.

Acreage (A, A^1, A^{11})

This is the area under irrigated ELS cotton each crop year. It is measured in (000's) feddan.[1] Such treatment, unfortunately, ignores the differences in soil fertility and all the other technical

(1) feddan = 1.038 acres.

properties of land under cotton caused by the vast areas under cotton and treated as homogeneous. The series are quoted for Gezira (A), all Sudan (A^1) and private estates (A^{11}) as given in the Bulletin of Agricultural Statistics, mentioned earlier.

Cotton stocks (S)

The choice of this variable was made on the grounds that changes in stocks are believed to be a disincentive to cotton output if they exceed a certain level. The significance of this was reflected in the Sudan Gezira Board[1] Act of 1960 which excluded cotton stocks exceeding 10% of total crop value in the accounts of current year for which the divisible proceeds are worked out.

This study deals with the extra long staple cotton produced on irrigated areas. The stock figures should in principal be related to this variety of cotton. But as no details of stocks were available, the figures quoted stand for all cotton stocks in the country as on 1st August of each year (series obtained in ooo's bales from I.C.A.C. Bulletins).

Another element of overestimation is introduced by taking the stock figures as on 1st August. While this is the end of the international marketing season, it represents the middle period of Sudan's. However, it is believed that the influence of the stocks variable would be imparted anyway as 1st August is a sowing time for the new season. The willingness of the growers to attend their new plantings would be affected if any undesirable marketing prospects were foreseen.

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(1) Sudan Gezira Board, Statement of Accounts, No. (11), p. 30. Barakat, Sudan.

Fertilizers (F_q, F^1, F)

The variable representing fertilizer input was taken in different alternative forms in search of an appropriate measurement and according to the nature of available data. This procedure was as follows:

(i) Total supply of fertilizers in the country (Fq), i.e. total annual imports of fertilizers as reported in Sudan Foreign Trade statistical reports 1945 until 1963/64, is one variable. This assumes that cotton production absorbs all the quantity imported of fertilizers and no stocks are considered from year to year.

(ii) To avoid the technical difficulties that arise from adding all the fertilizer components together and dealing with it as a homogeneous variable of equal nutritional content, it was thought better to take the deflated values of the annual quantity imported (F^1) as a proxy. The deflator is the wholesale price index for all goods, 1953 = 100.

(iii) The third fertilizer variable (F) pertains to the Gezira scheme alone. It is the actual expense incurred every year in fertilizers and their application to the cotton crop. The series is deflated by the wholesale price index for all goods, 1953 = 100. They were quoted from Gezira statements of annual accounts during the period 1950/51 - 1963/64. They were not available for an earlier date than that. No figures were available for actual quantity consumed, the fact which suggested the alternative of taking actual expenditure.

Certainly, the use of the monetary values of the variables is not without shortcomings in a technical relation like the production function. Yet the simplification is accepted in the light of data availability from which a maximum but meaningful result should be extracted. The crucial assumption however is that the monetary values approximate the physical units consumed.[1]

$\underline{Iq, I', I}$ The symbols stand respectively for total supply of insecticides, total deflated value of the quantity in supply each year and, finally, deflated actual expenditure on insecticides and spraying in the Gezira scheme 1950-51 - 1963/64. In all other respects what was discusse for fertilizers applies here.

Weather (W_t, W_{t-1}, W_s)

The impact of weather conditions on agricultural production in general, and in Sudan in particular, is very significant. Therefore any serious attempt to explain the variation in output should take into account the influence of this variable.

The construction of such an environmental variable depends upon:

(1) Knowledge of the technical impact of weather components (i.e. rain, temperature etc.) on the crop under study, as revealed by agronomic research.[2]

(2) The availability of such detailed components, so as to select the most relevant ones.

There have been, however, different approaches to the problem of a weather variable.[3] In this study the weather effect is

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(1) Lave, L.B., Technological change: Its conception and measurement, 1966, p. 139.

(2) Stallings, J. "Indexes of the influence of weather on Agricultural Output", J.F.E., 1960, vol. 42 (1).

(3) Oury, B. A production model for wheat and feed grains in France, 1966, chap. III, p. 23-34.

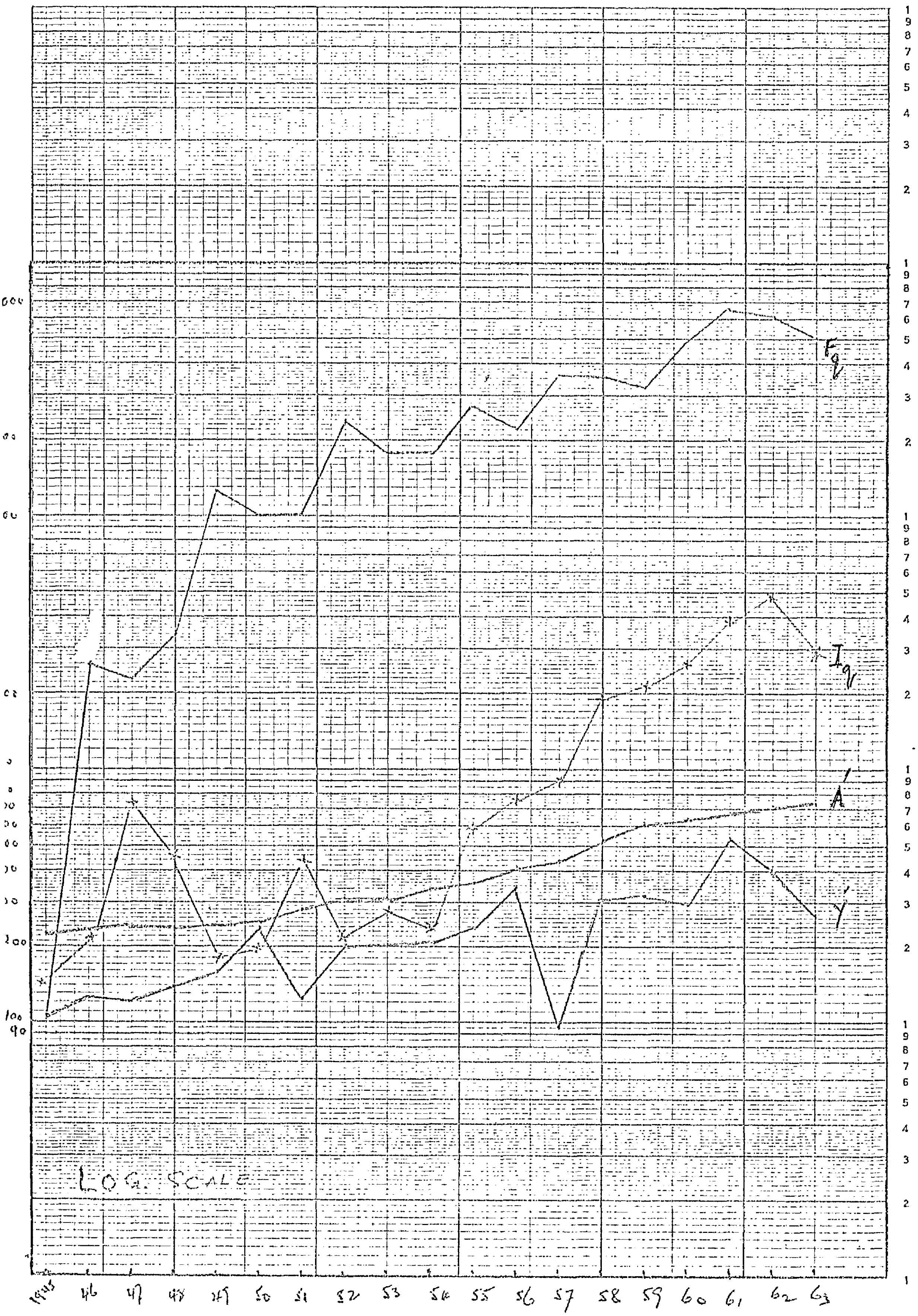

Chart (5.1): Total ELS Cotton, acreage, supply of fertilizers + pesticides for all Sudan represented by rainfall, which is taken to account for all the other weather components which are not technically known or for which pertaining data series are not available.

The rainfall variable, however, took the form[1] of three variables attempted in the analysis as follows:

(i) total annual average rainfall (W_t) in m.m.

(ii) total annual average rainfall with one year lag (W_{t-1}) in m.

(iii) total average presowing (July-August) rainfall (W_s) in m.m.

The variables are arithmetic averages of all the meteorological stations within the Blue Nile Province where most of the long staple irrigated cotton in Sudan is produced (including the Gezira scheme).

Rainfall figures are taken from Internal statistical reports, Dept. of Statistics, Sudan.

<u>Labour</u> (L_f,L_p)

Right from the beginning it was realized that if the labour input variable were to be included in the analysis, one would be forced to make some arbitrary assumptions. The variable here attempted is for the Gezira scheme cotton production rather than for all Sudan cotton estimates. The reason is the relative availability of some sort of crude series of this variable in the case of Gezira.

The variable is constructed with its two components: family labour (L_f) and hired (picking) labour (L_p).

(a) <u>Picking labour (L_p)</u>:

The Gezira scheme's annual statements of accounts show every crop year the number of cotton pickers employed. At the time of writing the series was complete except for 1962 and 1963.

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(1) Crowther, F. "A review of Experimental Work in Gezira", p. 493, <u>Agriculture in the Sudan</u>, by Tothill (ed.), 1948.

These two years were extrapolated from the available series on the assumption that the number of pickers varies every crop year with the volume of cotton output. Number of cotton pickers = f (cotton output, Y).

Fitting the trend of the available series 1945/46-1961/62, the following result was obtained:

$$L(p) = -\underset{(18.7)}{89.5} + \underset{(0.129)}{0.687}\, y \qquad \bar{R}^2 = 0.618$$

(b) <u>Family labour</u> (L_f)

The estimate of this variable is made on the following assumptions and information:

(1) The number of tenants is reported annually in Gezira records of Accounts.

(2) In a recent[1] study of labour in Gezira it has been reported that the family size, i.e. average number of persons per household, is 8.5. Out of these 8.5 persons, only 2.32 individuals are actually supplied to cotton tenancy work, i.e. 27.2%.

(3) Ignoring the difference in family sizes among the tenant population, the number of persons actually engaged in tenancy work (2.32) is multiplied by the number of the registered tenancies (i.e. no. of tenants). The total thus obtained is taken to represent the number of persons supplied to cotton tenancy work every crop year. For 1962/63 and 1963/64 the number of tenants was not available and had to be extrapolated as follows:

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(1) Hamid, A.A. <u>The Agricultural Labour and the Gezira Scheme</u>, 1964/65, p. 98-108, Sudan Gezira Board, Sudan.

No. of tenancies = f (acreage under cotton)

$$T = -11837 + 0.175\,A \quad \bar{R}^2 = 0.995$$
$$\quad\;\; (649) \quad (0.003)$$

The procedures followed to estimate family labour (L_f) extend the results of the family size, which is reported for the Gezira main scheme, to the new extension to the scheme (Managil area). Moreover, the same number of persons (2.32) reported for Gezira as the part of family labour supplied to cotton holdings operations in 1964/65 is used for the whole period of study 1945/46 - 1963/64.[1] This can be observed from the calculations of the number of family persons each crop year provided to cotton work, i.e. when multiplying the number of tenancies by 2.32 individuals supplied by each tenant's family.

Up to now two series have been constructed for the labour input variable in the Gezira cotton scheme: the number of cotton pickers (L_p) and the number of persons supplied from family labour to cotton tenancy work (L_f). The next step is to transform both (L_p) and (L_f) into a standard measure, i.e. conversion to man/day or man/hrs. equivalent. To do this we made use of the results of a sample survey[2] investigating 20 tenants in the Gezira scheme regarding the labour requirements for the different cotton agricultural operations, i.e. from pre-sowing activities until the crop is picked and handed to the board for marketing.

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(1) The survey whose results gave a family size of 8.5 persons covered the period 1958/59 until 1960/61 and therefore the results do not belong to 1964/65 - the issue date of the report.

(2) Ahmed, T.H. Economics of Agriculture in Sudan Gezira scheme, unpublished M.Sc. thesis, Aberdeen University, 1964.

Using the means of the series in the sample it was found that:

(i) Labour input required for the agricultural operations is 357 man/hrs/per feddan.

(ii) Labour input required for picking operations is 375 man/hrs/per feddan. Before using these estimates it should be pointed out that they are open to question as:

(a) The reliability of the information collected by the sample depends upon the memories of the tenants who do not keep records.

(b) In the present circumstances of the Gezira scheme (the sample was conducted in October 1963), the dis-satisfaction of the tenants and their persistent disputes to raise their share might have induced the tenants to over-estimate the labour requirements on which their profit share of cotton proceeds is based.

(c) The size of the sample (20) is relatively small compared with the tenant population in the Gezira scheme (30,000).

As the sample was taken in 1963, the man/hrs/per feddan (357 + 375 = 732) were multiplied by total acreage under cotton in that year. The resulting figure is supposed to be total labour requirements for the cotton crop in 1963. The total figure was broken down into requirements for agricultural operations and requirements for picking according to the ratio 357 : 375 or 49% to 51%.

On the assumption that the picking season lasts for 60 days[1] and both family labour and picking (hired) labour work together during this season, a figure of 11.5 man/hrs was arrived at as a working day.[2]

To arrive at the working day for the labour input going into the agricultural operations of the cotton crop in the Gezira (supposed to be mostly family labour), the following alternatives and assumptions were attempted:

(i) A working day of 4.2 man/hrs was derived on the basis of a working year of 300 days.

(ii) A working day of 3.9 man/hrs on the basis of a normal 275 days' working year.

Both estimates and assumptions of the working year were made with respect to 1963 data on all labour requirements for the cotton crop in the Gezira scheme as given by the sample referred to earlier.

On the assumption that the agricultural operations, i.e. from pre-sowing, sowing, irrigation (waterings) to cleaning are undertaken by family labour and no hired labour except that for picking, the labour input in the Gezira scheme came out as follows:

(a) 690 man/hrs per year per feddan for picking labour

(b) (i) 1533 man/hrs per year per feddan for family labour (300 days working year)

or (ii) 1424 man/hrs per year per feddan for family labour (275 days working year).

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(1) Hamid, A.A. <u>Labour in Gezira scheme</u>, 1964/65, Sudan Gezira Board.

(2) Hours per day during picking season = $\dfrac{\text{No. of man/hrs put into picking operations 1963 crop}}{\text{No. of pickers (hired + family labour provided for tenancy work)}}$

From the outset, these figures seem to be unsatisfactory estimates. For these figures to represent any labour input going into cotton production in Gezira, the estimates for family and picking labour should not differ widely from each other as is given by these estimates. The sample showed before that 51% and 49% are the proportions of the labour input, i.e. picking labour and agricultural operations requirements respectively.

Moreover when compared with labour input in other countries they show a wide disparity. They turned out to be very high when compared with those of Colin Clark who endeavoured to produce a general estimate of labour input in cotton production in Africa.(1) This is opposite to what is expected in context of the Gezira scheme conditions. It is believed that Gezira is favoured with an organization that facilitates the use of machinery in some of the agricultural operations.

The estimates even seem higher than those reported for cotton production in Egypt. Egyptian estimates stand as 41 man/days + 87 child/days per feddan per year. No man/hrs equivalent is given.(2)

The overestimation of labour input in Gezira can not, therefore, be ruled out. This is particularly so with regard to the family labour (L_f) component. It is due either to the assumptions about the length of the working year, or the constant application of the small sample result of 1963 over the whole period of study 1945/46 - 1963/64.

In view of the discrepancy observed between the labour estimates and those with which it is compared, we shall assume the most likely acceptab explanation: the estimate of family labour (L_f) in the Gezira scheme

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(1) Clark, C. Economics of Subsistence Agriculture, 1964, Chap. V, p. 69-95 (table XVII), p. 81.

(2) Issawi, C. Egypt in Revolution - Economic Analysis, 1963, p. 141.

does not represent the actual input going into cotton production over the period under study according to precise demand requirements. Rather, it is an estimate of the available labour supply from which cotton operations draw a constant proportion on top of that provided by hired (picking) labour. It is a capacity concept which may or may not necessarily mean that all the available supply of family labour is effectively utilized.

Because of the doubts surrounding the above estimates of labour input, another alternative was attempted for picking (hired) labour (L_p). This takes the number of pickers employed every season as the actual input representing this component of labour in cotton production in the Gezira scheme. Taking the number of pickers is more plausible and relatively more accurate than the arbitrarily defined man/hrs estimate. Picking labour in Gezira is employed on a piece basis and not on the number of hours worked per day.

Management (M)

The management is a qualitative factor which could not be quantified easily and with the same degree of reliability as other variables. Because of the significant emphasis on this variable by the institutional organization of the Gezira cotton scheme, it was felt necessary to attempt to include it in the analysis of cotton production. Its measurement is therefore bound to involve some arbitrariness and assumptions while the result would be subject to reservations. Ambiguity has always been there because of the fact that the management is a quality variable.(1)

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(1) Heady and Dillon, Agricultural Production Functions, 1961, p. 224-225. See also Griliches, Z. "Specification bias in Production Function", J.F.E., vol. (39), p. 12, and Nerlove, M., Estimation and Identification of Cobb-Douglas Production Functions, 1965, p. 91.

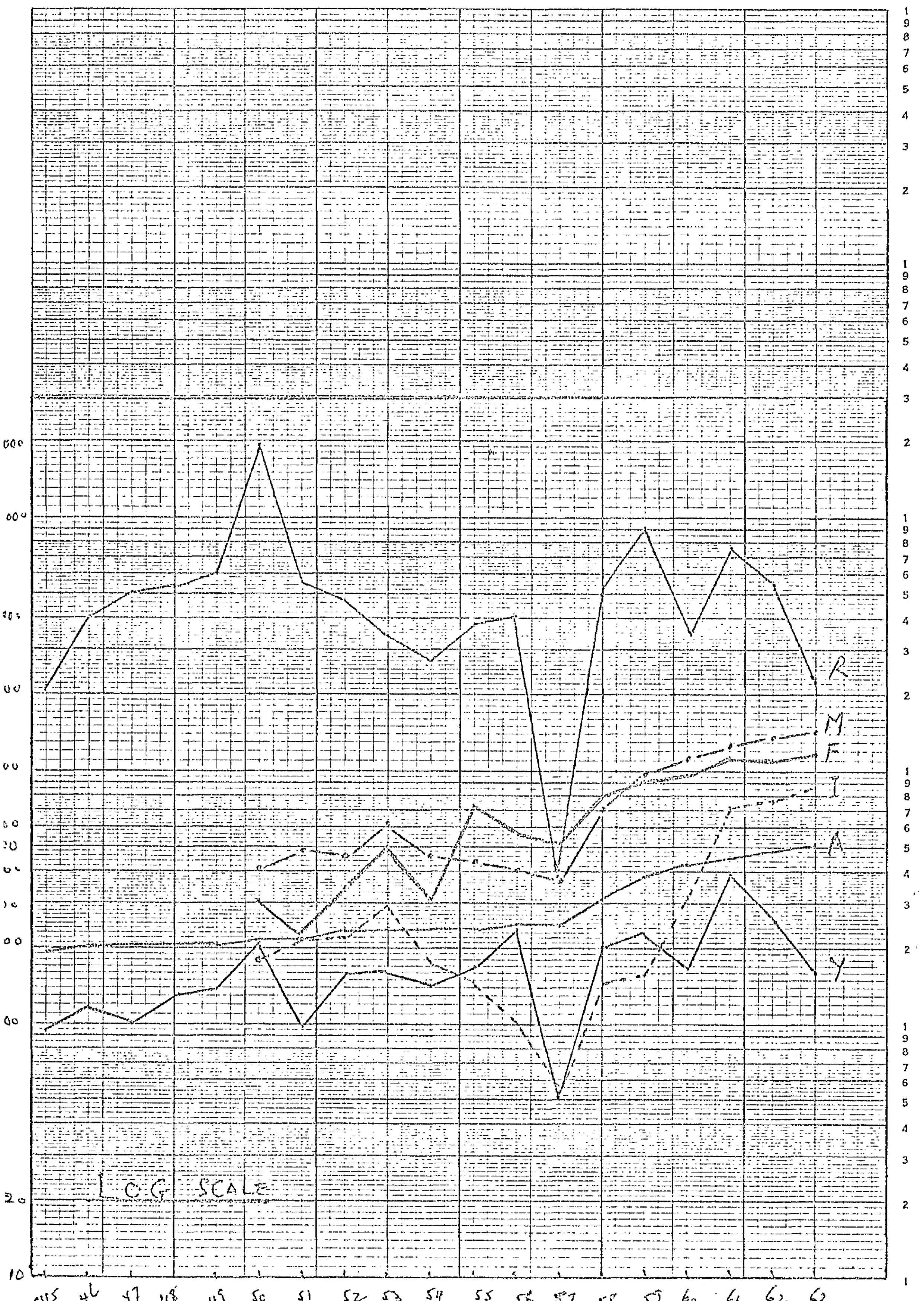

Chart (5.2): ELS Cotton output, Acreage, expenses incurred on fertilizer, pesticides, management and Tenants profit share

In our analysis the management variable in Gezira was represented by the annual expenditure incurred during the crop year against the management item (1950/51 - 1963/64) quoted from Gezira annual statements of Accounts.

As the management is made up of salaries, wages and remuneration as well as the expenses that facilitate the management task (vehicles, offices) it was deflated by the wholesale price index for all goods, 1953 = 100.

<u>Size of cotton tenancy</u> (Z)

This is another institutional variable. It is introduced to detect the influence of changing the size of the cotton holding on cotton production in the Gezira scheme. In other words it measures the scale of operations.

The variable representing (Z) is derived by dividing the area under cotton each crop year by the number of tenants registered in Gezira's scheme records.[1] Originally the cotton tenancies were planned to be of a standard size of 10 feddans. But with the growth of the tenant population and the increasing demand for (employment) tenancies, smaller sizes emerged by subdivision of some standard tenancies. This was a result of the slow expansion of the scheme's area at the early stages of the scheme and until the recent area expansions. Agricultural activities and the land are indeed the main sources of employment in a developing country like Sudan.

When the new area expansion to the Gezira scheme was launched in 1958 (Managil extension), the standard size of the cotton tenancy was reduced to 5 feddans. It was believed that reduction of the size was favourable to cotton production apart from the employment aspect. The test is directed towards investigating

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(1) Theoretically no one tenant is allowed more than one tenancy according to the first principles of the schemes.

this relationship.

Price Deflator

At the end of this part it is worth while mentioning that two price indexes were used as deflators. The wholesale price index of food, drink and tobacco was used for deflating the tenants' profit share (R). In all other cases the all goods wholesale price index was used. The preference given to the latter is due to the fact that it is weighted by cotton prices.(1)

For both price indices the base year is 1953. It represents normal circumstances throughout the period of our study 1945/46 - 1963/64. The beginning of the period would be influenced by the immediate effects of World War II, while any time during the 50's prior to 1953 would reflect the impact of the Korean boom.

Price indices are quoted from the internal trade reports, Department of Statistics, Sudan.

II. ELS Cotton Supply Function

(a) Introduction: the concept of the supply function causes some ambiguity.(2) Conventionally, it is defined as the relation between quantities offered for sale and their respective prices at a given time while other things are held constant.

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(1) The Ten Year Plan for Economic and Social Development, 1961/62-70/71, Khartoum, Sudan, p. 25.

(2) Cochrane, W., "Conceptualizing the supply relation in Agriculture", J.F.E., 1955, Vol.(37). See also Halvarson, H., "The response of milk production to price", J.F.E., 1958, Vol.(40).

In production economics, the supply response means more than that. It represents the relation between output and price changes under varying conditions. In other words it is the response of output to price changes when other things are not kept constant. The relation so conceived is dynamic, irreversible and influenced by changes in price, costs, use of inputs etc.

Essentially the supply response is a behaviouristic relationship measuring the producers' reaction (shifts in supply curve) to factors that are beyond their control. However, when the relation is specified, a trend variable is introduced to account for the omitted variables and the dynamic element involved. Otherwise, when price is the only explanatory variable in the relation, the whole effect would be attributed to it and the relation would be inadequately specified.

The question now is which price does influence producers' decisions and their output plans?

Economic theory does not provide what could be considered an adequate theory of behaviour under uncertain conditions. The answer to the question becomes, therefore, subject to empirical choice where some element of value judgement can not be ruled out. However the nature of agricultural production suggests the starting point.

Though all supply decisions take time to be implemented, it is a dominant characteristic in agricultural production. Here adjustment to market prices takes place with a time lag. Besides, agricultural activity is subject to random effects of weather conditions and relative resource fixity. All these features provided a good deal of justification to the Cobweb theory in attempting to explain, generally, how markets of agricultural commodities behave when they are out of equilibrium.

The accumulated literature on supply studies[1] can be grouped under expectational models which relate expectations to observable variables. In principle all of them are lag models and the distinction among them is only in theory. The differences, however, are in the lag assumed in each so as to represent the institutional and technological factors of the particular case.[2]

The different types concealed under expectational models can be sub-divided as follows:

(1) Extrapolative: The familiar example of this is the previously mentioned Cobweb model. According to this model past experience determines the expected value of the variable. Past experience is represented by a single lagged variable (i.e. of the previous period t-1), to which all the weight is given while other past experiences are considered non-influential and of zero weight. The most crucial assumption in this model is the competitive nature of the market and the absence of other factors that make the attainment of equilibrium between demand and supply less instantaneous (e.g. stocks, weather conditions).

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(1) M. Nerlove, Dynamics of supply, 1958. Also, Gardner, T. and Keith Cowling: "Analytical Models for Estimating Supply relations in Agricultural Sector: A Survey and Critique", Journal of Agricultural Economics, 1962/63, Vol.(15).

(2) Krishna, R., "Farm Supply Response in India-Pakistan", Economic Journal, 1963, p. 479.

(2) <u>Adjustment or adaptive</u>: Unlike extrapolative models, adjustment models tend to incorporate more periods of past experience that may have some influence on determining the expected value of the variables. Thus all previous experiences are a continuous flow by which the extrapolated expected variable is weighted.

According to adjustment models, expectations are revised periodically as "in each year farmers revise the price they expect to prevail in the coming year in proportion to the error they made in predicting price this period".[1]

Expressed mathematically the adjustment model takes the form:

$$\overset{*}{P}_t - \overset{*}{P}_{t-1} = \beta \, (P_{t-1} - \overset{*}{P}_{t-1})$$

Where $(\overset{*}{P}_t)$ is the expected price and (P_{t-1}) is the actual price last year and (β) is the coefficient of adjustment which reflects each time the efficiency of the forecast made earlier. $(0 < \beta \leq 1)$.

It is this adjustment coefficient (β) that ensures the element of continuity of the past values of the price variable. So these past values are a function of the coefficient (β) and according to the weights assigned to them by (β), the expected value of the price variable will emerge as a geometrically weighted average of past price values. This is shown mathematically as follows:

$$\overset{*}{P}_t = \beta P_{t-1} + (1 - \beta)\beta P_{t-2} + (1 - \beta)^2 \beta P_{t-3} + \text{----}$$

(β declines and tends to zero when moving backward in time).

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(1) Nerlove, M. "Estimates of Supply Elasticities of Selected Agricultural Commodities", <u>J.F.E.</u>, 1956, p. 496.

This formulation of the adjustment model is a development of certainty equivalent where each uncertain variable (non-observable) is replaced by one or more variables the value of which if expected with certainty would lead to the same solution.[1]

(3) Rational expectations model developed by Muth, assumes that the firm would behave as if it had made predictions of future events on the basis of rational predictions of economic theory.[2]

Previous researchers have used these models in their studies according to the suitability of each to the case in question.[3] These studies range from ones covering a single product to others for the aggregate supply function in agriculture.

(b) Sudan ELS cotton supply response

With the brief introduction made above we shall proceed to examine the supply function of Sudan cotton. This would involve choosing the appropriate model and obtaining the empirical estimates of the relation.

Contrary to our experiences in a free market economy where producers, in response to price changes, can alter their production or resource allocation, cotton growers (tenants) in Sudan's irrigated ELS cotton sector are in no position to do so.

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(1) Nerlove, M. and Bachman, K.L., "The analysis of changes in agricultural supply: problems and approaches", J.F.E., 1960, p. 540-545.

(2) Oury, B., A Production Model for Wheat and Feedgrains in France, 1966, p. 21.

(3) Stern, R., "Responsiveness of Egyptian Cotton Producers", Kyklos, 1959. Also Stern, R. "Primary Producers Response", R.E. Stats., 1962, "Determinants of Cocoa Supply in West Africa", African Primary Products, Stewart & Ord (ed.), 1965, "Malaysian Rubber Production", Southern Economic Journal, 1964/65. Nerlove, M. "Estimates of Supply Elasticities of Selected Agricultural Commodities", J.F.E., 1956, Halvarson, H., "The response of milk production to price", J.F.E., 1958, Grillicher, Z., "Estimates of Aggregate U.S. Farm Supply Function", J.F.E., 1960, Krishna, R. "Farm Supply Response", Economic Journal, 1963, Gardener, T. "The farm price and supply of milk", Journal of Agricultural Economics, 1962/63, Jones, G.T., "The response of supply of agricultural products in U.K.", The Farm Economist, Vol.(9) and (10).

As discussed in chapter III, the management in both Gezira and private pump schemes fixes the rotation, areas under crops and all the other inputs going into cotton production with the exception of the labour input.[1] Of all the resources engaged in cotton production, the tenants in such circumstances can vary only their effort.

Because of this institutional constraint, the hypothesis underlying the supply response will be modified and set to test as follows:

(i) management response to price i.e. reaction of planned output to price changes.

(ii) Peasants (tenants) response to price which would detect the impact of economic incentive i.e. increasing cotton yields through putting more labour effort.

(i) Management response: Acreage - price relationship

This relationship applies to both public (Gezira) and private cotton schemes. The management in these schemes decides on the planned output either through expanding the area under cotton or adjusting the use of other inputs. It needs to be emphasised that both Gezira and private schemes are under the control of the government. Private schemes' licences are issued with the condition that maximum cotton areas should not be exceeded. While the licencee can decrease or withhold the acreage under cotton, he is in no position to do the reverse in the upward direction following a rising expectation.

However, on the whole the cotton acreage expansion or contraction is expected to be in accordance with cotton price trend.

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(1) It can be fairly said that even labour input to an extent is determined by the management whose field inspectors insist that cotton agricultural operations be carried out to the required standards. This is particularly so in Gezira scheme.

The management response would therefore explain the investors' behaviour[1] in the Sudan cotton industry.

The model:

The acreage under cotton is taken as a proxy to the volume of planned output. This is the dependent variable to be explained by the cotton price variable. Ideally, the dependent variable should be the volume of output produced in the crop years covering the period of analysis. But because of the random effects of weather the relation between actual and planned output is obscured. In Sudan cotton output is strongly influenced by the weather variable (rainfall) despite the introduction of artificial irrigation. The variability of cotton output would therefore make the estimated supply response, measured from actual output, different from the planned level approximated by the acreage variable.

In order that the estimated elasticity of acreage should be equal to the elasticity of planned output it should be assumed that inputs other than land vary at least in proportion to acreage and returns to scale are not diminishing.[2] This assumption does not sound unreasonable in context of the institutional set-up of Sudan cotton, symbolized by its main Gezira scheme. One of its basic characteristics is the high level of standardization dominating the production process and use of inputs.

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(1) i.e. variation of fixed factors of production over time which is the main concern underlying investment theory.

(2) Krishna, R., "Farm Supply Response in India-Pakistan", Economic Journal, 1963, p. 479.

For the independent variables, only the price of cotton can be identified. There are no substitutes for cotton whose prices can be included. The weather variable (rainfall) is of doubtful significance as an explanatory variable as acreage expansion is primarily decided by the availability of artificial irrigation. Weather influence might be taken into account in initial feasibility studies preceding acreage expansion. Finally, prices of other inputs influencing costs, though important, are not available to be included in the estimates. The usual trend variable - catch all - is introduced to account for the omitted variables.

In choosing the estimating model which would depict the supply relation discussed above, distributed lag models would lend themselves readily as the management response is approximated to the investors behaviour. These models are useful where producers or consumers take time to adjust to changing conditions. The time element is believed to be of marked significance in Sudan cotton supply response. Reclamation of land, arranging for the necessary finance (domestic or foreign), rate of canal construction and irrigation and engineering works are constraints which delay the response of supply and makes it spread over time.

With this in mind and the non-significant results obtained from preliminary estimates, the Nerlove adjustment(1) model discussed before was chosen. The estimating equation of this model is as follows:-

$$A_t = a\beta + b\beta P_{t-1} + (1-\beta)A_{t-1} + C\beta T + u$$

where:

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(1) For an elaborate discussion see Gardner, T., "The farm price and Supply of Milk", Journal of Agricultural Economics, 1962/63, p. 59-65, also Nerlove and Addison, "Statistical Estimates of long run elasticities of supply and demand", J.F.E., 1958, Vol. 40).

A_t = Acreage under cotton in year (t)

A_{t-1} = Acreage under cotton in year (t - 1)

P_{t-1} = price of cotton in year (t - 1)

T = time trend

β = coefficient of adjustment which shows how much adjustment is made between desired and actual output

u = error term

a, b and c are constants.

However, distributed lag models are characterised by arbitrariness in specifying the length of the lag involved. There is no prior way of knowing the time path of the reaction and how many time units to allow in the computation.(1) As long as decision takes time, it is the constituents of this decision process which determine the length and form of the lag involved. It remains therefore to be settled empirically subject to trial and error (testing possibilities as hypothesis). Yet the guidelines are economic logic and statistical tests.

Results:

Using different price formulations with alternative lags we obtained the following results, summarized in the table below. The estimating equation was taken in logarithms of the variables and separate estimates were attempted for Gezira scheme (public) and private pump schemes.

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(1) Ibid, p. 59. See also Ferber and Verdoorn, Research Methods in Economics and Business, 1962, p. 343-348, Oury, B., A production model for wheat and feedgrains in France, 1966, p. 22.

Table 5.2.1. Acreage response function for Sudan irrigated ELS Cotton

1945/46 - 1963/64

Eq. No.	Price Variable and Lag	Regression Coefficient of Price	Regression Coefficient of Lagged Acreage	$\bar{R}$	$\frac{\delta^2}{S^2}$	Coefficient of Adjustment (β)	Elasticity Short run	Elasticity Long run
	(a) Gezira Scheme							
5.2.1	P_{t-1}	0.0900 (0.1007)	0.8651 (0.1186)	0.98	1.221	0.1349	0.09	0.007
5.2.3	P_{t-2}	0.0769 (0.1046)	0.8270 (0.1248)	0.98	1.301	0.1730	0.0769	0.444
5.2.5	P_{t-3}	-0.0335 (0.1117)	0.8351 (0.1428)	0.98	1.249	0.1649	-0.0335	-0.203
5.2.7	3 yrs. mov. Av.	0.2715 (0.2014)	0.7545 (0.1352)	0.98	1.362	0.2455	0.2715	1.166
5.2.9	2(t-1), 1(t-2) distributed lag	0.1601 (0.1502)	0.8058 (0.1254)	0.96	1.292	0.1942	0.1601	0.824
5.2.11	3(t-1),2(t-2),1(t-3) distributed lag	0.3562* (0.1930)	0.6852 (0.1422)	0.98	1.343	0.3148	0.3562	1.131
5.2.13	4(t-1),3(t-2),2(t-3), 1(t-4), distributed lag	0.5010* (0.2554)	0.5860 (0.1688)	0.98	1.252	0.4140	0.5010	1.210
	(b) Private estate							
5.2.8	3 yrs. Mov. Av.	-0.6205 (0.5380)	0.8917 (0.2013)	0.98	1.545	0.1083	-0.6205	-5.7

* Significant at 10% level.
All coefficients of lagged acreage are significant at 5% level.
All $\frac{\delta^2}{S^2}$ indicate no evidence of autocorrelation at 5% level.
Figures between brackets are s.e. of regression coefficients.

N.B. From estimating equation in the Appendix, the trend variable in all Gezira estimates shown in the above table is significant indicating an upward shift in supply. The net effect of the trend variable is obtained by dividing its regression coefficient by the adjustment coefficient (β).

Two distinct results are given for Gezira scheme and private estate acreage - price response. For Gezira the evidence suggests a very inelastic acreage response, as expected, in the short run.(1) This is given by the regression coefficient of price which is statistically significant only in two equations (equations 5.2.11 and 5.2.13). It means that the price variable has very negligible effects in the short run.

The long run elasticity, on the other hand, is fairly high the more we increase the length of the lag. Moreover by assigning more weights to recent years and including the effects of more specified but distant years the result becomes more significant. The long run acreage elasticity is determined by the coefficient of adjustment (β). On the whole the size of (β) is small in comparison with results obtained by previous researchers(3) in other countries, studying similar cash crops with the noticable difference in the institutional set-up of the present study.

The relatively low coefficient of adjustment (β) in Gezira cotton acreage response means that the adjustment between actual and desirable equilibrium values is slow and takes time.

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(1) Short run supply elasticity is obtained directly from the regression coefficient of the price variable when the estimating equation is expressed in logarithms.

(2) Long run elasticity, on the other hand, is computed from same equation by dividing the price regression coefficient by one minus the coefficient of lagged acreage.

(3)

	β	Elasticity Short run	Elasticity Long run
Punjab - Raj Krishna			
Cotton (A) (1922 - 1941)	0.44	0.72	1.62
Cotton (D) (1922 - 1943)	0.55	0.59	1.08
India - Venkataraman			
Jute (1911 - 1938)	0.64	0.46	0.73
U.S.A. Nerlove			
Cotton (1909 - 1932)	0.51	0.34	0.67

Source: Table 11, of R. Krishna's Article, "Farm supply response in India-Pakistan", Economic Journal, 1963, p. 485.

The result however confirms Nerlove's conviction of the usefulness of distributed lag models in estimates of supply response in situations where supply may be considered as perfectly inelastic in both the short and long run.[1] This effect is believed to be inherent in Sudan Gezira scheme because of institutional rigidity besides the other constraint on expanding the acreage under cotton.

However, the estimates may not be meaningful for practical policy projections due to the irreversible nature of the acreage supply response especially in a period of declining prices. Yet, the result is a useful indicator of the potential responsiveness to price changes that seems to exist in Sudan irrigated ELS cotton, approximated by the Gezira scheme under consideration.

Estimates of acreage - price response for private estates, on the other hand, showed quite distinctly the inappropriateness of distributed lag in explaining its behaviour. In all the estimates, except the one in table (5.11) above, with different price formulations, no significant result was obtained for price and it was not therefore significantly different from zero. Moreover, price regression coefficients retained the wrong (negative) unexpected sign. The lagged acreage variable accounted for all the variation and possibly its high inter-correlation with the trend variable influenced the significance of the results.

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(1) Nerlove, M. and Addison, W., "Stats. Estimates of long run elasticities of Supply and Demand", J.F.E., 1958, p. 850.

Both results obtained by distributed lag model and non-distributed lag model[1] suggest a negative supply response for private estates. Private estates have to maintain the same acreage under cotton with no possibility of increasing it beyond the authorized limit as prices take an upward trend. Some acreage is believed to be kept under cotton when the price of cotton is on the decline due to absence of other alternative crops and relative fixity of the resources engaged.

(ii) Tenants response: yield - price relationship

This is the complementary part to the management response discussed above. Both tenants and managers response would approximate the behaviour of cotton supply in response to price changes.

Tenants' response aims at detecting the behaviour of the peasants who, with varying their effort in response to price, are believed to influence the cotton supply (planned output). Effort of tenants includes labour provided from the tenants families and those whom they hire.

Elasticity of output is the sum of the planted acreage and planned yield per acre. It is only when the elasticity of yield with respect to price is equal to zero that the planned output elasticity is equal to the planted acreage elasticity. In Sudan, cotton yields are subject to strong variations, a fact which makes both output and acreage elasticities different more often than equal.

---

(1) An example of these non-distributed lag models is shown by the following result

$$\text{lag } A^{11} = 5.2659 - \underset{(0.2014)}{2.2306} \log P^{1} + \underset{(0.0221)}{0.1165t} \qquad \frac{\bar{R}}{0.97} \quad \frac{\frac{\delta^2}{S^2}}{0.822}$$

where:

A'' is acreage under cotton in private estates

P^{1} is 3 years moving average of cotton price.

Model and variables

The relation to be explained would be the yield per feddan,(1) while the price variable, weather (rainfall), cotton stocks and a trend variable will be the explanatory variable as follows:

$$(\frac{Y}{A}) = f(P, W, S, T, u)$$

u is an error term.

The institutional rigidity of cotton would eliminate the rationale behind distributed lag models from being applied to the yield price response as the tenants are in no position to reallocate resources over time. All that is expected is that part of the response to price should be manifested through variation in yield $(\frac{Y}{A})$. The price variable most likely to influence tenants' effort would be last year's price (P_{t-1}). However attempts with various forms of price variable including current price were made with no improvement on the results obtained and given below:

Gezira scheme 1945-1963

$$(5.2.15) \quad \log (\frac{Y}{A}) = 8.1075 - \underset{(0.3928)}{1.2284^{*}} \log P_{t-1} - \underset{(0.1542)}{0.4478^{*}} \log S_t - \underset{(0.4691)}{1.7602^{*}} \log W_{t-1} - \underset{(0.3239)}{0.2275} \log W_s - e^{\underset{(0.00727)}{0.00458t}}$$

$$\bar{R} = 0.80 \qquad \frac{\delta^2}{S^2} = 2.709$$

* Regression coefficient significant at 5% level.

$\frac{\delta^2}{S^2}$ indicate no evidence of autocorrelation at 5%.

---

(1) feddan = 1.038 acres.

Private estates 1945-1963

$$(5.2.16)\quad \log\left(\frac{Y^{11}}{A^{11}}\right) = 2.2248 - \underset{(0.3815)}{0.8486^{*}} \log P_{t-1} - \underset{(0.1702)}{0.4343^{*}} \log S_t + \underset{(0.00803)}{e^{0.00222t}}$$

$$\bar{R} = 0.56 \qquad \frac{\delta^2}{S^2} = 2.506$$

* Regression coefficient significant at 5% level.

$\frac{\delta^2}{S^2}$ indicate no evidence of autocorrelation at 5%.

The coefficients of the price variable in both estimates is significant at 5% and with the unexpected negative sign. The result tends to indicate that tenants have negative supply response to price changes. But could one conclude from this that cotton growers (tenants) in Sudan's cotton sector represent a case of a backward sloping curve of effort i.e. inverse relations between output and price?

To answer such a question we turned to test the relationship between cotton yields and tenants' incomes accruing to them from the crop they grow. In our present case, the tenants gross profit share (R) of cotton proceeds would represent this income variable. The series is available only for the Gezira scheme for which the estimate is attempted hereafter. Needless to repeat tenants' profit share (R) is what accrues to them after deducting the cost items of the joint collective account.(1)

The price of cotton is replaced by tenants' profit share per feddan $(\frac{R}{A})$ and the estimating equation of the relation becomes as follows:

$$\left(\frac{Y}{A}\right) = f\left(\left(\frac{R}{A}\right), W, S, T, u\right) \qquad u \text{ is an error term.}$$

---

(1) Joint collective account includes all incurred costs, except labour input whether family or hired, in cotton production during the crop year.

Fitting this equation we obtained the following result:[1]

Gezira tenants response 1945-1963

$$(5.2.18)\quad \log\left(\frac{Y}{A}\right) = -2.8387 + \underset{(0.0579)}{0.3252}\log\left(\frac{R}{A}\right) + \underset{(0.3215)}{0.8421}\log W_t$$

$$\frac{\bar{R}}{0.85} \qquad \frac{\frac{\delta^2}{S^2}}{1.967}$$

The result is quite significant. The regression coefficients of both $\left(\frac{R}{A}\right)$ and (W_t) are significant at 5% and their signs are logically as expected. The equation explains a considerable part of the variation in yields (72%) and has no autocorrelation among the residuals as $\left(\frac{\delta^2}{S^2}\right)$ indicates no evidence at the 5% probability level.

This statistical significance of the overall result, together with that of the income variable $\left(\frac{R}{A}\right)$ suggest that the assertion of Gezira tenants having a backward sloping curve of effort is not supported by the empirical evidence obtained. Tenants are more likely than not to respond to economic incentives i.e. varying their effort put into cotton production in response to the reward (income share) they derive from it. The tenants profit share (R) is, in a way, an approximate measure of the intensity of the labour effort of the tenants and whom they hire.

That tenants in Gezira cotton scheme prefer leisure with higher income is not substantiated by the result obtained above. This conclusion could be accepted if due regard is given to some considerations: firstly, the homogeneity implied in the scheme and tenant population may not be realistic. There are undoubtedly marked differences of soil fertility, climatic conditions and other location factors favouring cotton production over the scheme's area (over 2 million acres). Tenants are subject to different enterprising abilities and resources. Secondly, one should look into the degree of participation of both family and hired labour in the effort put into cotton production.

(1) Stocks variable (S) and trend turned out to be insignificant and were therefore dropped from the equation above.

Cotton is a labour intensive activity and the income elasticity of demand for hired labour is expected to be high with respect to leisure in cotton irrigated areas. In such a situation hired labour is not considered as a means of production but rather as a means of sparing oneself some of the drudgery of farm work or maintaining or increasing the opportunities for engaging in social activities.(1)

Finally, it is difficult to reconcile the results obtained between yield $(\frac{Y}{A})$ and price, on one hand, and yield and tenants' profit share per feddan on the other hand.

Farm income is determined by both levels of output and price of the product. Faced with declining prices, farmers are normally expected to increase their output to maintain the earlier level of income in case they decide not to shift resources to other uses. In context of the Gezira institution where areas under cotton are fixed and with no alternative crops, the logical consequence in face of falling prices is to increase yields per unit of land.

The plausibility of this explanation is not, however, in accordance with the actual facts in Gezira. During the period of analysis cotton yield on the average failed to register any significant increase (see table (1) Appendix B for rate of growth). But, on the other hand, it should not be forgotten that yields in Gezira are under strong influence of the rainfall variable as shown in the previously discussed estimates. The rainfall variables (W_t, W_{t-1}, W_s) turned out to be significant explanatory variable accounting for cotton yield variation. This would, undoubtedly, obscure the estimated relation as the effort the tenants put into their cotton crop may not result in the total output they actually plan.

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(1) Wilde, J., Experiences with Agricultural Development in Tropical Africa, I.B.R.D., Vol. I, 1967, p. 58-59.

Summary

Taking into account the limitations of the approach and data analysed, the following is a recapitulation of the main results that emanated from the study of the supply response of Sudan ELS cotton sector:

(1) In context of the institutional conditions of the cotton sector, the division of supply response into management response (acreage - price relationship) and tenants response (yield - price or income share relationship) proved to be a useful approximation to study of the cotton supply relation.

(2) Using Nerlove's distributed lag adjustment model, the results obtained for the Gezira scheme (i.e. public sector cotton), demonstrated clearly the rigidity imposed on cotton supply response by the institutional organization and other constraints.

For Gezira, the results suggest a very inelastic supply in the short run while in the long run the elasticity increases the more the length of the lag assumed in the computation is increased. In all the alternatives attempted, the estimates of both elasticities indicate a positive supply response.

Private estates, on the other hand, seem to have a negative supply response to price. The results are given by distributed and non-distributed lag models attempted.

(3) Tenants in both Gezira and private estates have possibly a negative supply response as this is suggested by the results of the yield - price relationship. Meanwhile tenants in the Gezira scheme tend to have a positive response to the reward they get from the effort they put into cotton production. This conclusion is based on the significant relation obtained between cotton yield and the income accruing to tenants (profit share) from cotton production in Gezira.

(4) Increasing cotton stocks seem to have a depressing effect on cotton yields in both Gezira and private estates.

III Production function of ELS cotton

(a) Introduction

This section deals with the production function of ELS cotton. By describing the relation between cotton output and the inputs put into it, the production function should provide more insight into the supply side of Sudan cotton sector, partly studied in the previous section.

The concept of the production function is a technical one. Its objective is to estimate the effects of each of the factors contributing to production as it exists in practice. Because of its technical nature (input/output) the production function is independent of market price and costs and tends to be valid under different circumstances.(1)

Production functions have been increasingly used as a tool of analysis in production theory which represents a central issue in the theory of growth and development. To an extent the difference between growth models is essentially a difference between the production function assumed in each model.(2)

Most empirical studies have been based on time series, (vs. cross section data), as the production function so derived evaluates past performance and helps to detect any possible disequilibrium in the resources used. Against this we have linear programming production models. They are short run models where some resources are fixed and the entrepreneur is given the choice of what he ought to do from the alternative solutions encompassed by the model.(3)

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(1) Khien, L. Introduction to Econometrics, 1962, p. 84.

(2) Kindelberger, C. Economic Development, 1965, chap. III, p. 40-60. Also Diwan, R. Short Notes on a Short Course in Applied Econometric 1964, unpublished notes, Department of Social and Economic Research, University of Glasgow.

(3) Walter, A.A. "Production and cost functions: An econometric survey" Econometrica, 1963, p. 13-14.

(b) Estimates and Results of Sudan cotton

In the present study we shall use the Cobb-Douglas function derived by the least square method and single equation approach (vs. a system of simultaneous equations comprising the production function relation as one of the several relations describing the economic phenomenon under inquiry).

The choice of Cobb-Douglas is because of its simplicity in interpretations and comparison with previous researches where it has been widely used. Admittedly, the choice of the functional form is a practical question as to whether the chosen form fits the data better or not.(1) However, it becomes more important if the parameters derived therefrom are to be used for income distribution.(2)

Because of data availability and the particular significance of the Gezira scheme the analysis undertaken hereafter will be divided as follows:

1945/46 - 1963/64

(1) Estimates for aggregate production function of ELS cotton (all Sudan

(2) Estimates for Gezira scheme ELS cotton production function.

1950/51 - 1963/64

(1) Estimate of Gezira scheme ELS cotton production function

(2) Sources of variation in Gezira scheme ELS cotton yields.

By first constructing and inspecting the simple correlation matrix of the variables thought to be logically underlying cotton production, a high degree of intercorrelation was found(tables 2, 3, 4 and 5 of Appendix (B)).

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(1) Preliminary experimentation with both simple linear equation and Cobb-Douglas (linear in logarth) gave quite similar results.

(2) Griliches, Z. "The Sources of Measured productivity growth in U.S. Agriculture", J.P.E., 1963 (August).

Though the presence of such a phenomenon, multicolinearity, is not ruled out among economic magnitudes in general, yet it is, in particular, a manifestation of the institutional organization of cotton in Sudan. According to its characteristics, most of the factors of production are believed to move together because of the relative degree of standardization involved (e.g. an extension of area under cotton means more tenancies, employment of labour, use of fertilizers, insecticide and most probably a corresponding increase in the management factor). All these magnitudes, on the other hand, will be moving with time. This is usually the major difficulty with non- experimental observed data.

The importance of this to our analysis would undoubtedly be in the influence it exerts on the choice and number of the explanatory variables included the estimating equations, as will be shown later.

(i) <u>Aggregate Production function of ELS cotton in Sudan 1945-1963</u>

The following is the best estimate obtained of the alternative regression equations attempted:

$$(5.3.2.) \quad \log Y^1 = -2.4915 + \underset{(0.1731)}{0.8405} \log A^1 + \underset{(0.4994)}{1.0146} \log W_t \qquad \frac{\bar{R}}{0.79} \quad \frac{\delta^2 / S^2}{2.197}$$

Of all the variables included in the estimate (Acreage (A^1), total supply of fertilizers and insecticides (F_q) and (I_q), rainfall (W_t) and trend variable), only (A^1) and (W_t) turned out to be the variables significantly explaining 62% of the variation in total cotton production (Y^1). Both (A^1) and (W_t) have regression coefficients significant at 5% level, while $\left(\frac{\delta^2}{S^2}\right)$ indicates no autocorrelation among the residuals at 5% level.

The insignificance of the fertilizers and insecticides variables may be due to inaccurate measurement or intercorrelation. Both variables were attempted in their quantities (F_q and I_q) as well as the respective values of the total quantities in supply every crop year $\left[(F^1) \text{ and } (I^1)\right]$.

The normal procedure in dealing with intercorrelation is to drop one of the intercorrelated terms in the equation or combine them together into one variable.(1) Obviously the acreage variable (A^1), which is believed to be the explanatory variable with which fertilizers and insecticides variables are intercorrelated cannot be dropped from the estimating equations without violating the logic of the cotton production process in question. Land in agricultural production gives the very special biological characteristic to the activity.

Taking both fertilizers and insecticides in their quantities per unit of land $(\frac{F}{A})_q$ and $(\frac{I}{A})_q$, did not improve the result obtained by equation (5.3.2.) above (see Appendix (B) equations 5.3.3 and 5.3.4).

The significance of the acreage (A^1) and rainfall (W_t) variables as the explanatory variables of the relation means that: Rainfall is of marked significance on cotton production in Sudan. The influence of the acreage (A^1) is overestimated in the relation as it is believed to conceal under it the effects of some of the intercorrelated variables dropped from these estimating equation or of those that were difficult to measure (e.g. irrigation). Land under cotton is a direct function of irrigation. The influence of this irrigation and its ancillary works, involving capital costs would largely affect cotton production but are difficult to measure in more detail for the purpose of this study

(1) Clark, C. and others, Business and Economic Forecasting, 1965, p. 26.

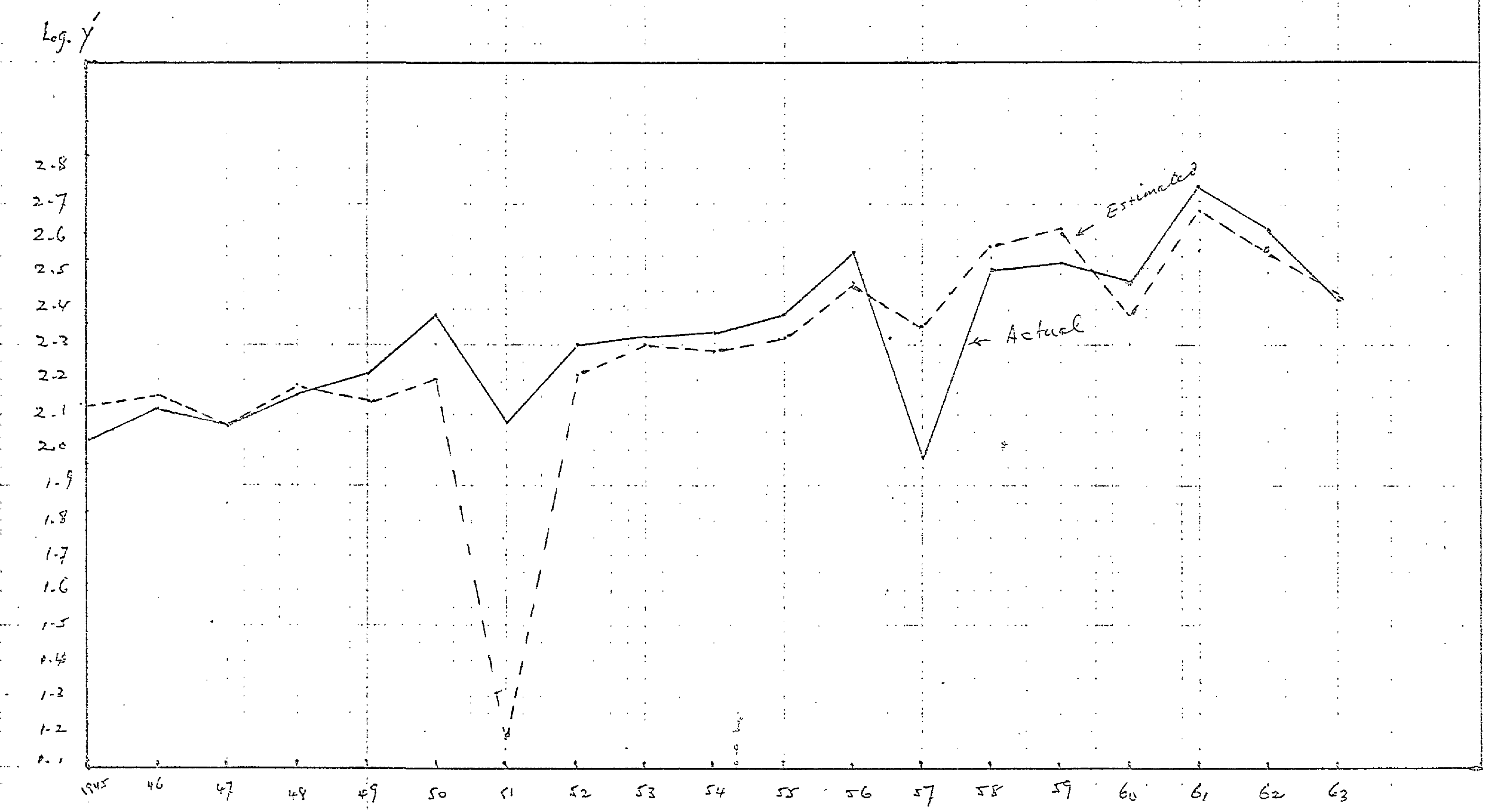

Chart (5.3) : Actual vs. Estimated Aggregate ELS Cotton production

The land regression coefficient in the equations appears, therefore, as a composite variable of the influence of land input and these variables.

Output elasticities and returns to scale:

Elasticity of output is the percentage change in output resulting from a one per cent change in one factor, others held constant. Returns to scale on the other hand, is the % change in output resulting from a one per cent simultaneous change in all the factors.

Accordingly, elasticities of ELS cotton output (Y^1) with respect to the factors in the estimating equation would be 0.8405 and 1.0146 for land and rainfall respectively. In the same way as individual elasticities, returns to scale may be affected by the omitted variables. In particular statements on returns to scale can be made only with respect to economic variables which are subject to appropriate changes in their uses.(1) In the ELS cotton production function investigated, only the land variable (A^1) can be identified for the estimate of returns to scale as rainfall (W_t) is beyond control.

The resulting estimate will therefore be equal to 0.8405. It indicates that the ELS cotton industry in Sudan is operating under diminishing returns to scale as 0.8405 is less than one. This conclusion is reinforced by another piece of evidence: in terms of growth rates, ELS cotton output (Y^1) increased at an annual compound rate of 7% against 7.65% for the acreage (A^1) under ELS cotton for the same period of study 1945/46-1963/64.

Output growth rate is the sum of the products of its elasticities and the exponential growth rates of the explanatory variables contributing to it.(2) According to equations (5.3.2) above, (A^1)

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(1) Heady and Dillon, Agricultural Production Function, 1962, p. 232-234.

(2) Minhas, B.S. "Measurement of Agricultural Growth", Indian Journal of Agricultural Economics, 1966, (Conference issue), p. 180.

is the only controlable variable to which one can apply the method of calculating the output growth rate, i.e.

$$\text{rate of growth of output} = \left\{\begin{array}{c}\text{the product of output}\\ \text{elasticity with respect}\\ \text{to land and growth rate}\\ \text{of land}\end{array}\right\} + \left\{\begin{array}{c}\text{product of output}\\ \text{elasticities and}\\ \text{their respective}\\ \text{growth rates of}\\ \text{other factors}\end{array}\right\}$$

$$\therefore \quad r = 0.8405 \times 7.65 = 6.4$$

which yields a difference of 0.6 between the actual growth rate (7%) and the one imputed by this method (6.4).

However, the dominance of diminishing returns to scale in the Sudan ELS cotton sector, as empirically suggested, could not be conclusively accepted before adequately specifying the other explanatory variables of cotton production besides the land factor (A^1) or examining the quality of the areas brought under cotton during the period of study. To do this, we shall consider the biggest component of the cotton sector, the Gezira scheme, in the following part.

(ii) The Production function of ELS cotton and yield variation in Gezira scheme:

The analytical significance of the aggregate production function is limited. This is because the problems underlying aggregation make the generalization of the derived results, based on the homogeneity assumption, less applicable. The following part is, therefore, devoted to the Gezira scheme which is believed to be relatively homogeneous compared to the whole ELS cotton sector considered before. But it must be emphasised that the single unit Gezira scheme, surely, is considered only fairly homogeneous for the purposes of the analysis attempted and implies no more than that. Gezira is a scheme covering nearly more than 2 million acres which makes it,undoubtedly, subject to different regional patterns of soil, climatic conditions and tenants population.

The analysis undertaken followed these steps:

(a) Examining the production function in Gezira for the period 1945/46-1963/64 and the sub-period 1950/51-1963/64.

(b) Examining the yield variation by taking the yield $(\frac{Y}{A})$ as the dependent variable instead of total output (Y) for the same data but only for the sub-period between 1950/51 and 1963/64.

This division between total production (Y) and yields $(\frac{Y}{A})$ as well as between the whole period and sub-period of study is justified by the following:

(i) To check whether the factors explaining output variation will also be responsible for yield variation (productivity aspect)

(ii) Division of the period is due to the nature and availability of the data in a way that allows continuity, meaningful results and comparability.

(iii) 1950/51 is the year when the Gezira scheme was nationalized and a new managing board took over from the private company. The board is running the scheme at present on the pattern evolved during the private company's concession period (1925-1950).

(iv) Any criticism made on ELS cotton production is automatically thought of in context of the Gezira scheme, a fact that makes an appraisal of its performance appropriate.

The model used, included the variables usually relevant to similar conditions of cotton production to which Sudan is no exception. This includes technological variables; land $(A)_1$, fertilizers, (F), insecticides (I) and labour L, environmental variables; (rainfall W_t, W_{t1}, W_s) and institutional variables, (management M, and size of cotton holding Z).

The following results summarized in table (5.3.2) represent the estimates selected for the production functions and yield investigated:

Table (5.3.2) ELS cotton production and yields functions in Gezira scheme

1945/46 - 1963/64

and

1950/51 - 1963/64

Eq. No.	Period	Regression Equation fitted	$\bar{R}$	$\frac{\delta^2}{S^2}$
5.3.8	1945-64	$\log Y = -3.3706 + \underset{(0.1891)}{0.6149^{*}} \log A + \underset{(0.2342)}{0.7784^{*}} \log L_p + \underset{(0.4378)}{0.8715^{***}} \log W_t$	0.82	1.757
5.3.18	1950-64	$\log Y = -3.6293 + \underset{(0.1766)}{0.3286^{***}} \log A + \underset{(0.1913)}{0.8491^{*}} \log L_p + \underset{(0.3652)}{1.1953^{**}} \log W_t + \underset{(0.0975)}{0.4057^{*}} \log (\frac{I}{A})$	0.92	2.646
5.3.28	1950-64	$\log (\frac{Y}{A}) = -3.3633 + \underset{(0.1350)}{0.7597^{*}} \log (\frac{L_p}{A}) + \underset{(0.3430)}{1.2570^{**}} \log W_t + \underset{(0.0915)}{0.4304^{*}} \log (\frac{I}{A})$	0.91	2.711

* Regression coefficient is significant at 1% level.

** Regression coefficient is significant at 5% level.

*** Regression coefficient is significant at 10% level.

All $(\frac{\delta^2}{S^2})$ indicate no evidence for autocorrelation.

The results in the above table show a high and marked correlation between the explanatory variables and the dependent variables in the equations. Though the degree of explanation[1] (given by $\bar{R}^2$) differs over the two periods yet it reflects the rationale of dividing the period of study.

However, high intercorrelation between the explanatory variables specified to explain the relations together with the basic constraint put on the present study by the small sample size, limited the inclusion of more variables than those given in table (5.3.2).

Taking into consideration the way explanatory variables are measured and the computational procedures adopted, the variables appearing in the selected equations (table 5.3.2) as well as those omitted and the problems of their formulation will be discussed hereafter This should enable us to assess the influence of each on both output and cotton yields in Gezira scheme.

Land (A)

From the results in table (5.3.2) the acreage variable emerged as a significant explanatory variable in both periods of study. The result obtained for 1945/46-1963/64 raises some questions about the significance of land input to cotton output when compared with the estimate of the sub-period 1950/51-1963/64.

The result does not, as it stands, mean that the contribution of land, judged by its regression coefficient (output elasticity as the equation is in logarithm), is greater in the whole period than in the sub-period. On the contrary the result shows that the

(1) This would be 68% and 84% for total output while 81% for yield equation.

estimate of land input is overestimated for the Gezira cotton production 1945/46 - 1963/64, in the same way as in the aggregate production function for all Sudan ELS cotton discussed before. In both cases the land coefficient conceals the influence of land and that of the terms correlated with land but dropped from the estimating equation. The evidence supporting this argument is given by equations 5.3.8 and 5.3.14 table 8 of Appendix (B).

In examining these equations one would notice the following: The coefficient of land (A) is nearly the same (0.6) when the same set of variables are introduced into the estimating equation of both periods. The difference between the degree of explanation given by these two equations (as reflected by their $\bar{\bar{R}}^2$ 68% and 58% respectively), is bridged when the relation is better specified. This better specification is given by equations nos. 5.3.9 and 5.3.15, table 8, Appendix (B), for both periods where the rainfall variable is introduced as the previous year's total rainfall (W_{t-1}) and rainfall of the six weeks before sowing every year, (W_s). Here the same set of variables is used to account for cotton output variation. The result obtained is a similar regression coefficient for land (0.7) in both periods while the degree of explanation is almost the same ($\bar{\bar{R}}^2$ = 65% and 61% respectively).

However, when better specifications of the relations explaining cotton output was made possible with the availability of more data in the sub-period, an approximate coefficient for the land inputs' influence was obtained. It amounts to (0.3) which compared to the estimate given for 1945/46 - 1963/64 (0.6), would superficially look different. The inclusion of the insecticides variable ($\frac{I}{A}$)

is believed to account for the indirect effects of the rainfall variable which together with (W_t) improves the fit on that obtained by equation no. 5.3.15, table 8, Appendix (B).

This explanation given for the coefficient of the land variable does not, however, rule out the possibility that the contribution of this input is generally less in the sub-period than its counterpart for the whole period 1945/46 - 1963/64. It is given as a possibility as the evidence could not be obtained directly from estimating the respective parameters of land in both periods. This cannot be done without having more detailed data that would enable better specification for cotton output relations in the whole period 1945-1964.

The low contribution of land input in Gezira cotton production during the sub-period is suggested by the following: For the whole period, cotton output increased at an annual compound rate of 4.4% against a statistically non-significant from zero growth rate for the sub-period, while acreage under cotton increased at a rate of 5.5% against 7.7% respectively. It is during the sub-period that the biggest extension to the Gezira scheme was launched. This is the Managil Extension which nearly doubled the original area of the Gezira scheme.

The failure to achieve a significant increase in cotton output commensurate with the acreage increase during 1950/51 - 1963/64 could probably be attributed to the following: Land input might have been increased beyond what could be considered as the "best proportion" of factors used in cotton industry.[1] Such a situation

(1) Boulding, K. Economic Analysis, Vol. I, (student ed.) 1966, Chapter 25.

would give rise to diminishing returns as a consequence of falling marginal productivity of land. According to the institutional organization of cotton production in Gezira, inputs are believed to be increased in fixed proportions which may create and favour conditions of constant returns to scale. But during the sub-period it seems that the implied principle of fixed proportionate changes in factors of production was less adhered to. The result has, therefore, been a negligible increase in output (1) despite the vast increase in acreage as revealed by their imputed growth rates referred to above.

The other factor to which the decreasing contribution of the land input could be attributed is the fact that the expanded acreage in the sub-period (Managil) is of ~~a~~ less fertile soil i.e. a marginal land to cotton areas of Gezira main. The evidence to this effect is given by considering the yields of cotton in both parts between 1958/59 (2) and 1965/66 as follows:

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(1) This insignificant role of acreage is suggested by the yield $(\frac{Y}{A})$ equation in table (5.3.2) above. Compared to the equation of total output for the same period 1950-63, the degree of explanations of yield variation, size and significance of regression coefficients is nearly the same.

(2) 1958/59 is the date when Managil area began to come under cotton cultivation.

Table (5.3.3) Cotton Yields variation in Gezira Main and Managil Extension

1958/59 - 1965/66

Season	Gezira Scheme	
	Main	Managil
1958/59	4.704*	4.671*
1959	4.574	3.434
1960	2.716	2.908
1961	6.611	5.383
1962	4.340	3.396
1963	1.845	2.746
1964	3.723	3.375
1965/66	2.860	3.387
Average	3.921	3.662

*Yields are in Kantar per feddan (Kantar = 141.5 kg. of unginned ELS cotton)
(feddan = 1.038 acre of land)

Source: S.G.B. statement of areas and yields of cotton 1956/57 - 1965/66, Barakat.

Though the average yield per unit of land is not the appropriate measure of the productivity of land, yet the result of actual yields comparison should serve as a rough indicator, assuming that differences in climatic conditions and tenants adaptability to cotton production are taken into account, in both parts of the scheme.

The conclusion however is that: the evidence suggests that the contribution of land input in Gezira cotton scheme is relatively lower in the sub-period than in the whole period of study. The net effect of land input can better be derived if the influence of the factor concealed under the estimate of land and dropped from the estimating equation are detected. The need for such adequate specification of the relation is illustrated by comparing the estimates discussed before for Sudan ELS cotton aggregate production function and that of Gezira for the whole period and the sub-period of study.

If the Gezira scheme is to be considered as a fairly representative unit for irrigated cotton production in Sudan, the results obtained for it can be compared, where possible, with those previously made for the similar variety of cotton grown in Egypt.(1)

In both Sudan's and Egyptian studies, land emerged as a significant variable contributing to cotton production. Using the Cobb-Douglas production function, Shayal's study, covering the period of 1915-1953 with the war years 1940-1945 omitted and introducing only land and per feddan fertilizer variables, came out with an output elasticity of 0.776 for land. The second study of Khier El Din covering the years 1913-1960 and with land, labour and total fertilizers, gave an elasticity of cotton output with respect to land of 0.7215. Comparing these two results with that of Sudan 0.3286 during the sub-period 1950/51 - 1963/64, the contribution of land input in cotton production in Sudan is smaller than that in Egypt. Taking into consideration the data limitation and the sample size the conclusion is not surprising as the land under cotton in Egypt has been subject to intensive use because of the relatively inelastic supply of land. Greater output elasticity is expected for land under such intensive use conditions.(2)

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(1) Shayal, S.E.M. An Econometric Study of Price Formation and Demand for Egyptian Cotton, unpublished Ph.D., Oxford University, 1960. Also, Khier El Din, H., The Cotton Production Function in U.A.R., 1963, Institute of National Planning, Cairo memo no. 370.

(2) Heady and Dillan, Agricultural Production Functions, 1962, p. 631.

Labour

This variable was attempted in the preliminary estimates with two components: family labour (L_f) and picking labour (L_p). The reason for this division is that picking labour (L_p) constitute the bulk of the hired labour in cotton production in the Gezira scheme. As these two labour components (L_f) and (L_p) are complementary rather than competitive, each component needs to be assessed separately.(1)

But because of the crudeness and tentative nature of the family labour estimate and the non-significant result(2) obtained it was dropped from all the estimating equation of the production and yield functions of cotton in Gezira. Use has therefore been limited to the picking labour (L_p) for which a series of data is available.

Picking labour, mostly taken as hired labour, is more reliable to consider as an actual input going to cotton production. Picking is the most labour-intensive of all cotton agricultural operations, representing more than 50% of total labour requirements. The special importance of this variable is that hand picking is a key factor in ELS cotton as a top quality cotton fibre. Moreover it is believed that in Gezira mechanization is extended increasingly into cotton growing operations where labour requirements are drawn from family sources. The discussion hereafter is confined to (L_p) only.

As expected, (L_p) turned out to be a significant variable influencing both cotton output and yields in both periods of study. Output and yield elasticity with respect to picking labour is relatively high.

(1) Heady and Dillon, Agricultural Production Function, 1962, p. 223.

(2) Non significance is due to presence of high intercorrelation between (L_f) and acreage under cotton (A). High intercorrelation between (L_f) and (A) is a consequence of the method used to estimate (L_f) as is shown in section I (data and limitations) before.

Hired labour, unlike selfemployed labour, is expected to work at levels commensurate with the wage rates. Picking labour being the major constraint (peak season), its contribution to cotton production is expected to be relatively high.

In a recent report on labour in Gezira scheme, it has been suggested that the productivity of picking labour has been declining.(1) This suggestion was based on the increasing number of pickers required per feddan during the period between 1930/31 and 1958/59. From the present study, however, no conclusive evidence could be given in this respect. The reason is that our study is confined to the period between 1950/51 and 1963/64 and it is difficult in the absence of the respective prices of the product and picking labour to make use of the derived marginal productivity of labour from the estimates in table (5.3.2) above. But the whole unsatisfactory issue of the picking labour position (supply and productivity) could be better explained in context of the labour position in the country as a whole.

During the sub-period under investigation, big construction and development projects were introduced with the Sudan Ten Year Plan 1960/61 - 1970/71. This together with the sizeable increase in acreage under cotton (Managil), put a heavy drain and increasing demand on the unskilled labour previously attracted to cotton growth centres. The resulting competition led to rising wages and reduced the monoponistic position of the cotton schemes in the labour market.

Seasonal employment, as best illustrated by cotton picking operations, does not generally favour any improvement in agricultural

(1) Hamid, A.A., The Agricultural Labour and the Gezira Scheme, 1965, p. 108.

labour productivity. The particular significance of this to Sudan cotton schemes is that the migratory labour constitutes the bulk of the seasonal labour force. Cotton pickers between their sources of origin and centres of seasonal employment can hardly settle down to engage in an activity that would improve their skill or create an adequate inducement to acquire more. In a sparsely populated country like Sudan, the adoption of a stable agricultural pattern that permanently engages the labour force would lead to more production with continuous tendencies and possibilities of improving productivity.

Rainfall (W_t, W_{t-1}, W_s)

As in the estimate of ELS aggregate production function, the rainfall variables proved to be of strong influence in the Gezira scheme as well. This is reflected by examining the results in table (5.3.2) above. The significance of the rainfall variable in both periods of study shows how cotton production in the Gezira scheme is still dependent on rain despite the introduction of artificial irrigation.

Previous studies(1) on rainfall in Gezira did not provide a conclusiv explanation of the real effects of this factor. It is believed that the rainfall variable influences cotton yields in Gezira favourably when it rains heavily during the six weeks preceding sowing (W_s) and adversely through heavy total rainfall during the previous year (W_{t-1}).

Following this specification of the rainfall variable it was introduced into the estimates of both periods and the results were as follows: for the whole period the overall fit was not improved

(1) Burhan, H. "Review of Yield-Rainfall relationship", Sudan Agricultural Journal, 1965, No. 2.

(equation no. 5.3.9, table 8, Appendix (B)) on the one obtained using total current rainfall (W_t), equation (5.3.8), table (5.3.2) above. For the sub-period the degree of explanation of the variation in cotton output and yield was increased but it was no better than the results obtained by the equation given in table 5.3.2. In both cases (W_{t-1}) and (W_s) retained the expected signs to the effect of adverse influence by (W_{t-1}) and favourable influence by (W_s).

Therefore in our main estimate we preferred to use (W_t), total annual rainfall. The results improve considerably when the insecticide variable is introduced. Insect attacks are believed to represent the indirect effects of the rainfall variables. The adverse effect imparted by previous year's total rainfall (W_{t-1}) is manifested through the insect attacks which shift from the fallow weeds to the new cotton plantings in the current year. More interesting therefore is the fact that previous year's rainfall (W_{t-1}) degenerates as an influential variable in presence of the insecticides variable $(\frac{I}{A})$ in one equation. (5.3.18 vs 5.3.19, table 8, Appendix (B)) The same occurs for yield level $(\frac{Y}{A})$ (equations nos. 5.3.28 vs 5.3.29, table 8, Appendix (B)).

Accordingly, one would expect a strong positive correlation between (W_{t-1}) and the insecticides variable (I). Contrary to this assertion, a negative and insignificant correlation was found between them ($r = -0.230$). The result, therefore, tends to question the existence of a functional relation, as postulated between insect attacks and the previous year's total rainfall.

This conclusion seems to be in agreement with the view that "some of the most important intermediate factors such as insect pests, though they may depend on rainfall, are not consistently proportional to its intensity".(1) Therefore, of the estimates attempted, in the selected equations in table (5.3.2) above, preference was given to (W_t); total current year's rainfall together with insecticide variable to approximate the overall effect of the rainfall/variable on cotton in the Gezira scheme.

A basic difference between the present study and the previous ones concerning the question of rainfall is that rainfall is introduced here, into the estimating equation, explaining the variation in output and cotton yields, together with other variables influencing cotton production. However, the result obtained does not claim to be a full explanation of the whole weather effects. The study of rainfall effect on cotton production in Gezira is a subject of its own. It is imperative to assess its influence on a broader technical basis that encompasses the different components of the weather variable in its entirety. In terms of development economics this would help to detect what is caused by the weather variable and what is attributable to development effort.(2)

Such study becomes highly pressing and worthy if the issue is as summarized by the agriculturalist in his review article "...that effect of rainfall in yield is mostly indirect

(1) Ibid., p. 67-71.

(2) Ram Dayal, "A study of rainfall effects", Indian Journal of Agricultural Economics, (July-September), 1965.

"and secondly that most of the factors through which the influence of rainfall is conveyed to yield fall in the category of controllable factors..... Adequate nitrogen application at appropriate times, proper disease control, proper control of insect pests by frequent and timely spraying, pre-irrigation to induce weed germination for control, as well as other improved methods of culture may all contribute to the elimination of the deleterious effects of poor pre-sowing rains and reduction of seasonal yield fluctuations as a whole."(1)

Fertilizers and Insecticides

These are among the new modern inputs to agricultural production. Their introduction is expected to be closely associated with increasing output. Yet the availability of financial resources sets limits on their period and speed of adoption. In other words, it takes a long time, depending on realization of their effects and the ability to finance, to have them in full use.

The Gezira scheme in this respect is in an advantageous position. It is directly connected with the agricultural research station where experiments are conducted. The large scale and relative availability of finance(2) are favourable conditions, created by the institutional organization of the scheme, for the use of these modern agricultural inputs.

(1) Burhan, H., "Review of rainfall-yield relationship in Gezira " Sudan Agricultural Journal, 1965, p. 68.

(2) Compared with other cotton schemes and parts of agricultural sector, Gezira tenant's stand more chances for credit because of the advantageous position of Gezira scheme in the credit market. However, as items of expenditure on new inputs (e.g. fertilizer and insecticides) appear in the joint collective account of cotton production, there is a limitation on incurring more costs if their contribution to cotton production would not be favourable. The items of the joint account affect directly the divisible gross proceeds of cotton which is of great influence on tenant's profit share in the scheme.

As in the estimates of ELS cotton aggregate production functions, no significant results were obtained for the contribution of both fertilizers and insecticides in Gezira scheme between 1945 and 1963. This is due to the difficulty of measuring these variables as actually consumed in cotton production. However, in the absence of such data, the alternative attempted was to use total supply of both variables as they exist for the whole country. These figures were taken as the quantity imported every year with no adjustment made for stocks carried forward. The basic assumption is that the Gezira scheme consumes a constant rate of the total supply figures which are mostly used for cotton production in the country. The validity of constant consumption rate of total supply by Gezira scheme, while it seems reasonable for fertilizers, is less plausible for insecticides. The consumption of the latter would depend on insect attacks and cotton diseases, a fact that makes it less proportional and constant. Yet no improvement was gained over the result given in table (5.3.2) above. It is believed therefore, as discussed before, that part of their influence is concealed under the acreage coefficient which is strongly correlated with both total supply of fertilizers (F_q) and insecticides (I_q) and their respective deflated values F^1 and I^1.

For the sub-period 1950/51-1963/64 more detailed data is available on both fertilizers and insecticides used in cotton production in Gezira. Actual costs of fertilizers and insecticides were used as a proxy as the actual respective quantities consumed were not available. This is, undoubtedly, not the ideal alternative as the production function is a technical relation between the physical amount produced and the quantities of inputs used. It is an input/output relationship. The use of deflated values of the respective actual costs of fertilizers (F) and insecticides (I) was based on the assumption that the quality of these variables has not changed over the period of study. Though this might be a very dubious assumption, the results obtained are believed to be a suggestive approximation of the direction and magnitude of the influence of these variables on cotton output and yields. Because of its association with the rainfall variable just dealt with above, insecticides will be discussed first.

Insecticides:

As shown in table (5.3.2), insecticides proved to be a significant variable contributing to both production (Y) and yield of cotton $(\frac{Y}{A})$ during the sub-period. To combat multicolinearity with acreage, both fertilizers and insecticides were taken in their per feddan input $(\frac{F}{A})$ and $(\frac{I}{A})$ respectively. This specification raises certain objections.

Minhas,[1] emphasising the differences between extensive and intensive magnitudes, objects to the use of such per feddan input as a variable explaining an aggregate relationship like total cotton production (Y). In such a relation where both extensive variables e.g. land (A) and labour (L_p) and

(1) Minhas, B.S., "Measurement of Agricultural Growth", Indian Journal of Agricultural Economics, (Conference issue), 1966, p. 176-181.

intensive magnitudes e.g. $(\frac{F}{A})$ and $(\frac{I}{A})$ are introduced to the estimating equation, the interpretation of the results becomes ambiguous. Statistically, Minhas suspects that multicolinearity would be reduced by such procedure unless the changes in the intercorrelated terms, for which transformation is made, are proportionate.

The validity of these criticisms for the results obtained in the present study can not be ruled out. The intercorrelated variables; acreage (A), fertilizers (F), insecticides (I) and management (M, to be discussed below), have not been changing proportionately over the period of study 1950/51 to 1963/64. This is contrary to what is expected under the Gezira institution where factors are believed to be proportionately moving because of the relative degree of standardization applied. Transformatio of the variables into their per unit ~~of~~ land input does not seem to have reduced the influence of multicolinearity. Except for insecticides $(\frac{I}{A})$, which initially was relatively less correlated with acreage than (F) and (M), no significant results were obtained for estimates including the transformations made.

Fertilizers:

As referred to above no significant regression coefficient was obtained for fertilizers with respect to output of cotton (Y). This was the case with all the alternatives attempted as shown in Appendix (B).

On the yield level $(\frac{Y}{A})$, relatively better estimates were obtained. In most of the equations fertilizer input retained a positive sign indicating its favourable effect on yields of cotton. However, in only one estimate did $(\frac{F}{A})$ have a regression coefficient of (0.4426) almost significant at 10% level (equation no. 5.3.24, table 8, Appendix (B)).

Fertilizer application in Gezira has been increasing considerably. Total expenditure on this variable recorded an annual rate of growth of 13.1% against 10.4% for per feddan level during the period 1950/51 to 1963/64. Despite this growing expenditure there is no evidence to suggest that the maximum is drawn out of it. The reasons to which the low benefits were attributed are the inappropriate method and timing of application.(1) The present application by hand leads to uneven distribution and hence reduces the balanced effectiveness of this input. Moreover Gezira tenants are said to use part of the fertilizers intended for cotton for other crops (e.g. Dura) or in some instance, illegally, sell it. Whether fertilizer meant for cotton is used for other crops or sold to bodies outside the scheme, the incidence reflects the lack of an incentive which makes cotton a profitable activity attracting due concern from the tenants.

Fertilizers are applied between November and June i.e. before the rain. By changing this timing, the Gezira Agricultural Research Station (G.A.R.S.) obtained significantly

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(1) Working Party's Report Development of Agriculture in the Main Gezira Scheme, Ministry of Agriculture, Khartoum, 1966, p. 81-84.

different cotton yields for fertilizers application at sowing time (July-August) when rain is expected to be at a maximum.(1) Yield difference reported amounted to 0.332 Kantar per feddan for the crop year 1963/64. This would suggest that better effects of fertilizers could be derived from applications close to sowing and maximum rains.

In this connection the empirical evidence in the present study seems to support the above conclusion. The only significant results for the fertilizer variable $(\frac{F}{A})$ is obtained when both rainfall variables (W_{t-1}, previous year's total rainfall and W_s, pre-sowing July-August rainfall), were introduced together with $(\frac{F}{A})$ into the yield estimating equation no. 5.3.24, table 8, Appendix (B).

Improved fertilizers practices, ensuring even distribution and appropriate timing for application of the prescribed doses would, most probably, create favourable conditions for better responses between this input and cotton yields in Gezira scheme. Moreover, tenants should be induced through proper measures and incentive to give their attention to cotton as well as to other crops which are not subject to profit sharing arrangements.

Management and cotton tenancy size

These two variables represent the institutional elements which are believed to have some influence on the supply and production of cotton in the Gezira scheme. The study of their effect is confined to the sub-period 1950/51 to 1963/64 only.

(1) Ibid., p. 82.

Management (M): As has been referred to when discussing the supply response in the previous part, it is the management of the scheme which makes the entrepreneurial decisions concerning the supply of ELS cotton in the Gezira scheme. The other part it plays is related to production of cotton. Here the management is expected to be an effective element contributing to the production and yields of cotton through prescribing practices and supervising tenants on the field.

In testing this hypothesis, the variable constructed to represent the management input (M) was subject to the phenomenon of intercorrelation with other explanatory variables (acreage, fertilizer and insecticides). This led to insignificant estimates in both output (Y) and yield $(\frac{Y}{A})$ regression equation shown in the appendix (equations nos. 5.3.11, 12, 5.3.22 and 5.3.25).

However, when all intercorrelated terms with the management input were dropped from the estimating equation, the management variable $(\frac{M}{A})$ retained a significant coefficient. It indicates that a positive relation exists between per feddan expenditure on management $(\frac{M}{A})$ and cotton yield $(\frac{Y}{A})$ in the Gezira scheme (equation 5.3.30, table 8, Appendix (B)).

This result is as expected. Yet because of its tentative nature, pending better specification and measurement of the management variable the significance of the result needs some qualification.

According to Gezira institution, the tenants are closely supervised and their work is connected to the loans and advances made to them during the crop year. These were believed to be the factors of efficiency in the early days of the scheme.(1) By then, tenants were newly introduced to modern agricultural practices and planting a crop the demand for which was expanding. The foreign private company helped with such organisational structure to spread and diffuse among the tenants the modern agricultural techniques. The field inspector at the field level kept these techniques at relatively high standards by insisting on a certain quality of work being performed by tenants.

With these conditions changing, it is believed that the management input is not optimally used. Tenants in Gezira are more used to agricultural practices than before. Their consciousness of economic opportunities draws the attention to lay the emphasis of the management factor on different basis than the present paternalistic attitude. In other words, reliance on economic incentives is more favourable to growth of productivity than administrative control especially with the stagnant conditions of demand for ELS cotton.

By 1950/51 a new administration took over with the foreign staff being replaced by local recruits. The structure of the management remained the same as to the routine, channels and all that evolved during the private company's concession period 1925-1950. In other words the factors of efficiency referred to above were preserved. Therefore the same results were expected to continue had it not been for the changing conditions of tenants and cotton trade and the relative qualitative difference in the new field staff during 1950/51-1963/64 compared with previously.

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(1) Gaitskell, A., Gezira, 1959, p. 208.

The following is a quotation from a recent report on labour in Gezira by one of the scheme's staff. Writing on the management input he says "...the field staff are not selected because of any agricultural back-ground nor subjected to any special training course on their appointment. Certainly this is a defect which can be rectified in due course by their gained experience and training on the job. But until then, it would not be out of place if many of the field staff were branded for their lack of prior agricultural knowledge or managerial experience of handling problems of such specialized class as the tenants."(1)

Professor Heady reinforces this line of argument on the quality of the management input and its specification by saying "... usual procedure has been to rate the sample of entrepreneurs on a managerial index relative to their knowledge of farming practices and techniques and the degree of economic rationality thought to be shown by their current managerial decisions relative to use of recommended practices."(2)

The lack of technical knowledge among the field staff in Gezira, who are supposed to be the key management input responsible for a successful growth of cotton output and tenants' productivity, is coupled with a lack of mutual trust between them and the tenants in the scheme. The field staff inherited the out-dated paternalistic authoritative attitudes towards the tenants. With the growing social and economic consciousness

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(1) Hamid, A.A., Labour in Gezira Scheme, p. 151-152.

(2) Heady and Dillon Agricultural Production Functions, 1961, p. 224-225.

of the tenants, this led to a frustrated situation and the emergence of a strong Tenants' Union to defend their position. Such an environment of industrial relations takes place while the tenants are theoretically a third partner in the scheme. It is not a surprise therefore that the tenants have been striving for full partnership and representation on the scheme's management until very recently (1965).

On the occasion of a recent strike by Gezira field staff, the Secretariat of Tenants' Unity issued the following statement which reflects their views on the management of the scheme: "The present crisis is a part of the big problem and needed reform of the whole institution. The bureaucratic centralized administrative machinery which involves considerable costs should be devoluted to the tenants to whom the management of the scheme should be handed. At the same time the present field staff should be replaced by agriculturally trained supervisors instead of the inherited authority of the ex-field inspectors before ending the private company's concession. By doing so they will be in a position to guide and help the tenants".(1)

During the period of 1950-64, the actual expenditure of management has been increasing at a compound rate of 10.3 per cent a year. Such vast amount of expenditure introduces rigidity and inflexibility in the cost structure of cotton production in Sudan.(2)

However, the fundamental features of the Gezira scheme could be preserved while some reforms could be launched to keep to the pace of social and economic development in the tenants' society and the country in general. The effectiveness of the present-day management input portrays something about its

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(1) Akhbar El Isboa (Arabic) No. 62 of 18/2/67 (A Sudanese weekly paper).

(2) The management of the scheme takes 10% of net cotton proceeds from which all the management items are paid.

quality and structure during the period of study. The management input could be more effective if applied to the optimum level and with the required standard. Most of the present-day debates on development agriculture put great hope on scale and management. The Gezira case does not wipe out such hope, rather it supports the argument for more competent and technically trained personnel. This, together with adjusting the institutional set-up to the changing conditions, would create more favourable conditions for output and productivity growth.

In sum, a management input that could provide the required extension service and guidance together with associating the tenants with the active running of the scheme would be of great effect at a time when more intensive cultivation is embarked upon in the Gezira scheme.

<u>The Size of cotton tenancy</u> (Z): This is the last explanatory variable in the relation of output and yield of cotton in the Gezira scheme. Tenancy size refers primarily to cotton, the purpose crop of the rotation.

From the beginning, the scheme's area was divided into standard sized tenancies. They were to be distributed among the applicants as a single tenancy to each. The purpose was to make it a family based holding which could be laboured by the tenant's family and those whom he hired.

Gezira being the biggest scheme and centre of employment in a country still predominantly engaged in agriculture, the principle of standard tenancy size could not be adhered to. With the growth of population and increasing number of applicants, the inelastic supply of Gezira area led to decreasing tenancy size (Z). However, it must be stated that this did not take place on a large scale and was restricted as much as possible.

But with the introduction of the Managil extension to the Gezira scheme (1958-1963), the size of the additional cotton tenancies was reduced from 10 feddons to 5 feddons. The reasons were: to cope with providing more employment for the growing labour force, at a time when employment opportunities elsewhere were not expanding, and to create favourable conditions for the growth of cotton output. It was thought that by reducing the size, the labour requirements would be mostly met from family labour which was believed to be underutilized and hence needed more tapping. Increasing contribution of family labour in tenency work could not be traced out during the period of study because of the difficulty of measuring the actual input going to cotton production as has been discussed before. But the point to which the investigation is directed with regard to size of cotton tenancy is whether or not reduction of size led to increased output of cotton.

Examining the results obtained for both output and yield estimates, no significant result was attained for the tenency size variable (Z). It has a regression coefficient not significantly different from zero indicating that the reduction of cotton holding is of doubtful significance in increasing cotton output and yield in Gezira scheme between 1950/51 and 1963/64.

From preliminary investigations, the conclusion obtained for tenency size above seems to be unexpected. In the matrix of simple correlations (table No. 5, Appendix B), cotton output (Y) and (Z) are negatively correlated. (Y = -0.467 significant at 10% level). This, however, was not substantiated when (Z) was included in the multiple regression estimating equation as one of the explanatory variables influencing variation in cotton output (Y). Before discussing the contradiction between the two results reference should be made to the way variable (Z) is constructed to detect the hypothesised influence on cotton output (Y).

The policy decision to reduce the tenancy size was initially related to the new extension (Managil), while in Gezira main, the reduction of size from the original standard came about as a result of ad hoc decisions taken as circumstances arose. In our analysis we did not differentiate between the two parts of the scheme. This aggregation is not without shortcomings. Because of data availability, the regional differences, though recognized, were ignored. The whole scheme was taken as a fairly homogeneous unit; a simplification which so far did not adversely influence the purpose of our analysis. Its impact on the point in question; the tenency size, is believed to be less serious than is suggested by the contradiction mentioned before. In actual fact, the tenency size (Z) in both Managil and Gezira main is approaching the smaller size favoured by the purposive policy decision to reduce (Z) in Managil extension.(1

(1) While 81% of Managil cotton tenencies is of 5 feddan size, the distribution in Gezira main is as follows:

Up to 5 feddans	6-10 feddans	Over 10 feddans
48.3%	48.3%	3.3%

Source: Hamid, A.A., Agricultural Labour and Gezira Scheme, 1966, p. 100.

It is, therefore, believed not to be unreasonable to take (Z) as the average number of feddans per tenant of the whole area under cotton each crop year.

In his study of labour in Gezira, Hamid[(1)] found that for the Gezira main, smaller tenency size (5 feddan) enjoyed more of tenants' family work which declined with increasing the size of tenency. In Managil extension the mal-distribution of tenencies by allotting one to every member of the household led to inadequate labour provided by family sources for tenency work. Our result indicating that reduction of (Z) is of doubtful significance on increasing cotton output and yields reflects the central tendency generally exerted by reduction of size which would have agreed with Hamid's comments on both parts of the scheme. Yet another factor which most likely influenced the increase in cotton output subsequent to reduction of (Z) is the possible disincentive created by the level of income derived from the smaller size tenencies compared to the effort put in.

The size of the cotton tenency is directly connected with the question of scale. Optimal combination of inputs would lead to favourable conditions of increased production and employment of resources. Deciding on the appropriate size could not, however, be divorced from the dominating social attitudes and economic environment. Because of the possible development and changes in these conditions, an element of flexibility should be maintained so as to accommodate them, the result being the relatively appropriate decision.

The following would be an example of the factors to be taken into consideration on the question of tenency size in Gezira.

(1) Ibid, p. 100-111, 166.

(1) Regional differences including tenants' abilities, soil fertility and climatic conditions.

(2) Size should not be relatedto family size alone. Essentially tenencies are family holdings yet this needs some flexibility to accommodate more enterprising tenants who could cultivate efficiently more than one tenency making use of hired labour beyond their family source. Hired labour here would be a factor of production and not used to spare oneself from the agricultural work. It has already been alleged that family labour in Gezira is underutilized. So by allowing more bigger tenancies for the efficient tenants, an atmosphere of competition or rather a demonstration effect would be created. In Gezira more reliance on economic incentive is believed to be more effective than the present close supervision based on a paternalistic attitude towards the tenants. The management task, traditionally facilitated by the relative standardized practices for the single crop cotton, would be very difficult with the introduction of other crops besides cotton. The shift of the management emphasis on the field level together with other appropriate measures would create a favourable environment for the emergence of more motivated, market oriented tenants.[1]

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(1) In his study of India's farms and their efficiency according to size Rao maintains that "the problem is not so much the under-utilization of management input among small farms as the diseconomies of large scale operations arising from the managerial and supervisory bottlenecks". Rao, C.H., Agricultural Production Functions, Costs and Returns in India, 1966, p. 39-41.

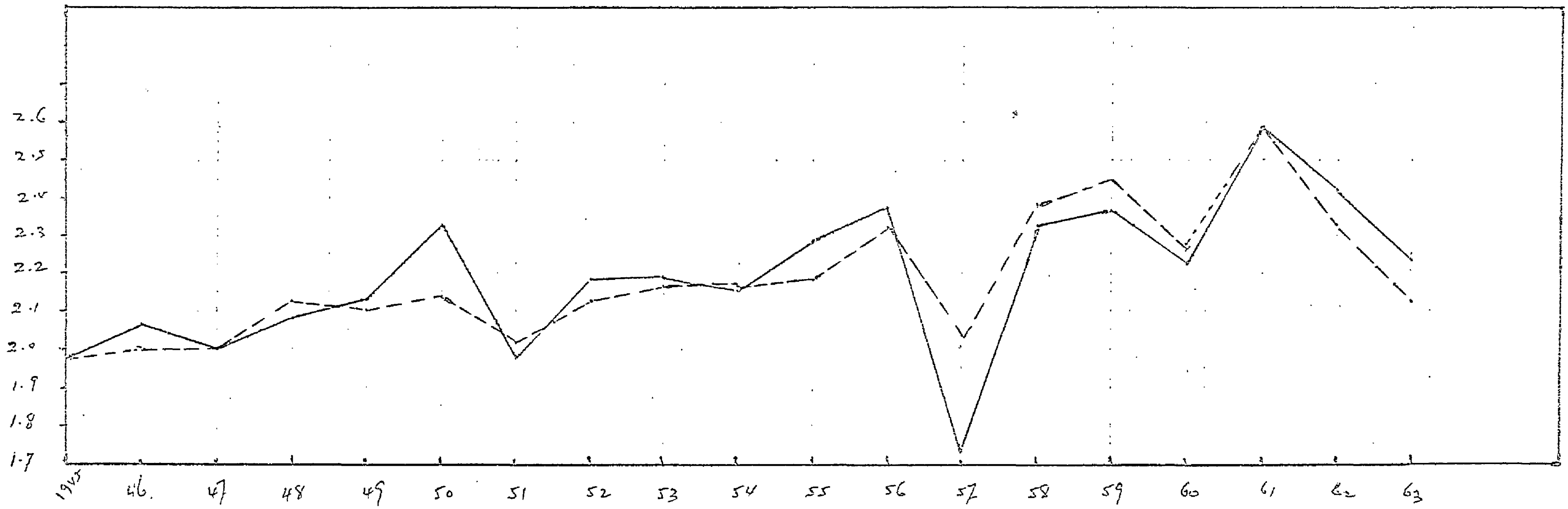

Chart (5.4)

Actual vs. Estimated ELS Cotton production in Gezira Scheme

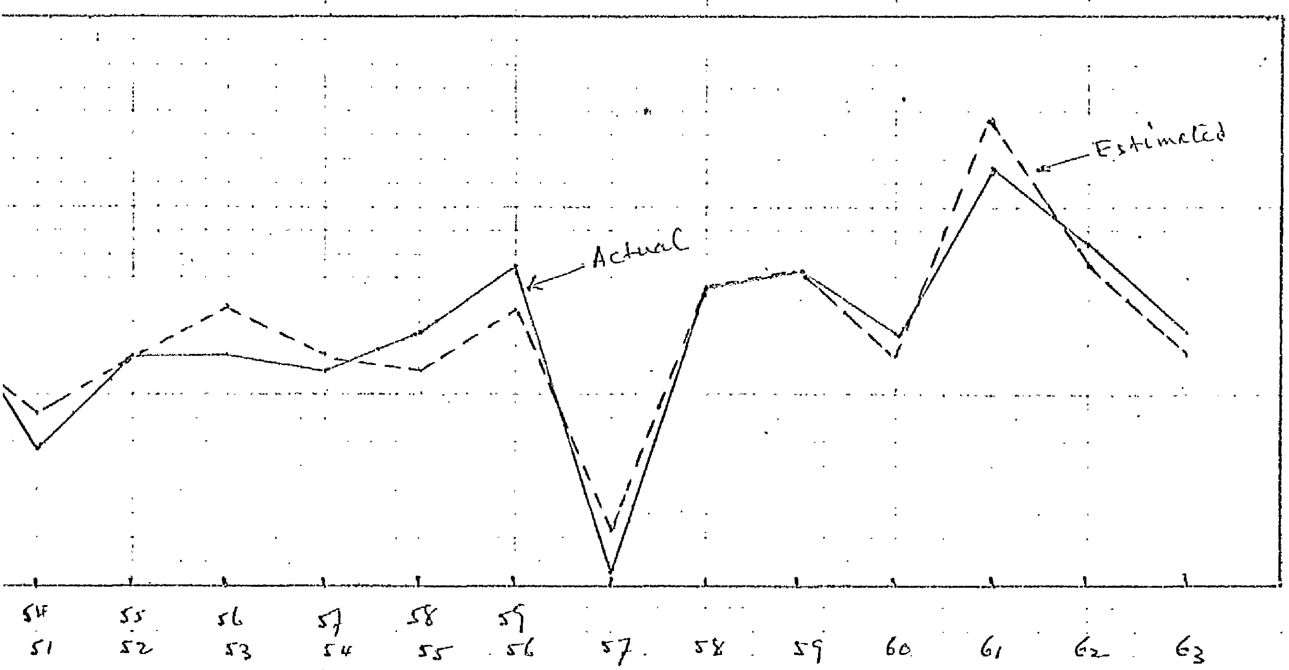

Chart (5.5) : Actual vs Estimated ELS cotton production in Gezira scheme 1950 – 1963

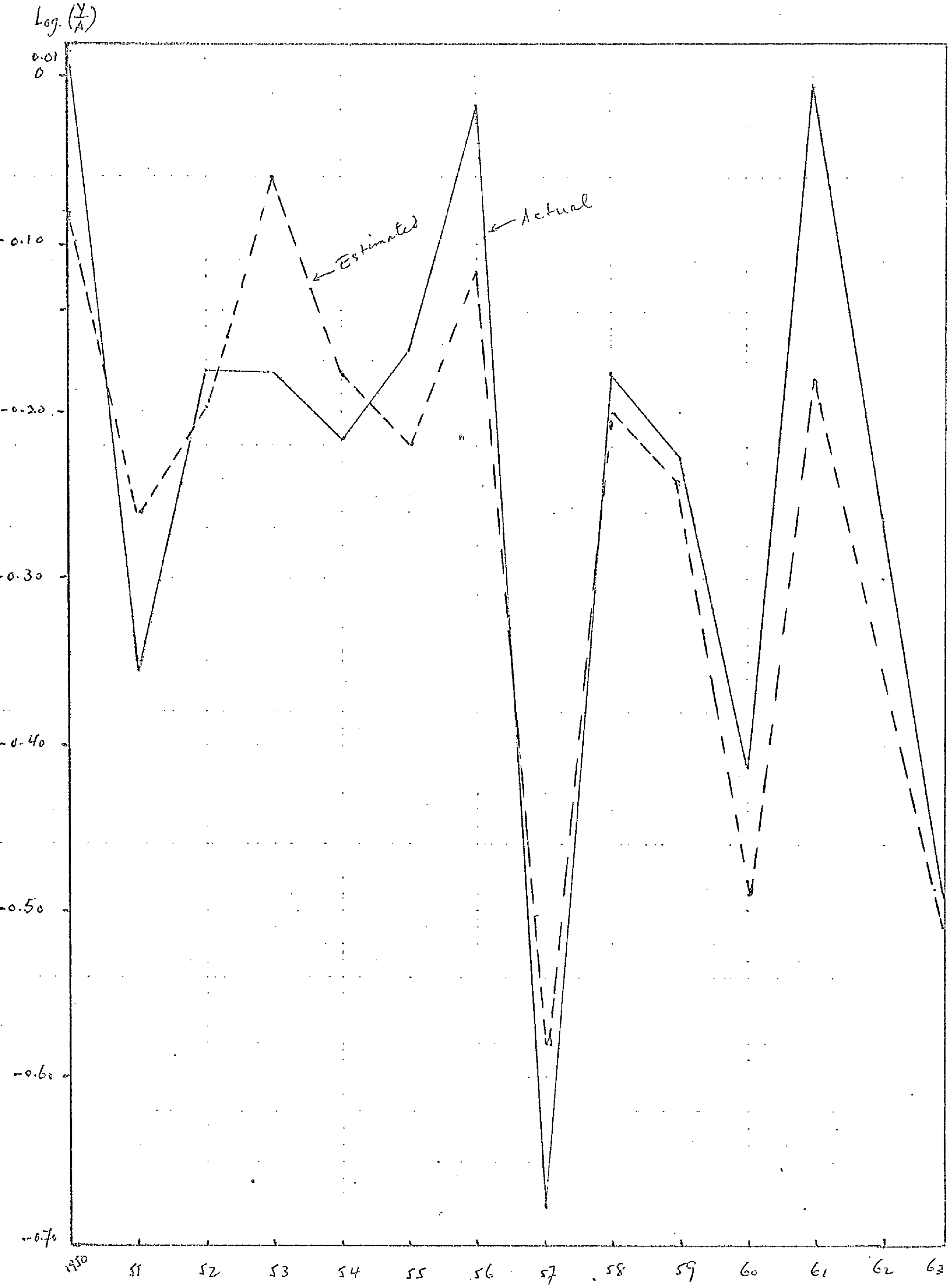

Chart (5.6): Actual vs. Estimated ELS Cotton yield in Gezira scheme 1950 — 963

Marginal productivities and returns to scale in Gezira scheme

Production function, marginal productivity and returns to scale are among the analytical concepts developed for the single firm. They are similarly extended to situations where aggregates and broad categories dominate, assuming conditions of competitive equilibrium. Gezira scheme and the whole cotton sector for that matter, come under those aggregated broad categories. Yet applying the concepts is not believed to be a serious simplification. In the Gezira scheme, because of the relative degree of standardization, inputs are not combined in various proportions on the different tenencies.(1) This would imply that techniques adopted are not different.

Returns to scale: Referring to table (5.3.2) and judging by the sum of the output elasticities with respect to the economic controllable factors, it seems that Gezira is operating under increasing returns to scale. The sum of output elasticities resulting from a one percent increase in those factors is significantly greater than one. The result seems to support our belief that the whole ELS cotton sector does not operate under diminishing returns to scale as was given by the elasticity of the land input only and discussed before.

However, the fact that in the Gezira scheme cotton is produced under conditions of increasing returns does not mean that each producing unit (i.e. tenancy) in the scheme is working under the same conditions if taken separately. Gezira scheme organisation,

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(1) Assuming that the tenancy would represent the firm level.

by offering a great deal of external economies of scale to the constituent producing units of the scheme, created favourable conditions for increasing returns to scale to be encountered on the aggregate level of the whole scheme.(1)

Marginal productivities: Theoretically marginal productivity of a factor contributing to a certain productive process is defined as the additional output (or return) resulting from an additional use of one unit of the factor in question.

The derivation of marginal productivities would be meaningless unless it were used as a guidance for practical policy recommendations. To this effect, the estimates of production function parameters obtained, so far, provide one set of the needed information to discuss the efficiency or disequilibrium of the resources engaged in cotton production. Without the market prices of these factors or their opportunity costs in other uses no such evaluation could be attempted. Usually the ratio between the value of marginal productivity and the price or opportunity cost of the factor determines whether it is efficiently used or not. If the ratio is greater than one the use of the factor could be increased profitably and vice versa.

There are, however, some limitations to deriving an efficiency measure as mentioned above and based on production function estimates and the relevant market information. These limitations, which have to be taken into consideration when using the estimates, are as follows:

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(1) Significant reduction in costs is caused by the scale of Gezira operations whether in purchase of inputs, use of machinery or provision of irrigation.

(1) The Cobb-Douglas functional form usually used in production function studies does not allow the various ranges of returns to scale which the factors in question undergo. Instead only increasing, decreasing or constant returns are given. This would imply that the marginal productivity of the factors remains unchanged while in fact it is a result of the constant elasticity assumed in the Cobb-Douglas function. As the marginal product of a factor depends on the level of combining it with other factors of production, estimates of equilibrium quantities based on this type of function becomes less satisfactory.

(2) If market prices are subject to imperfections, the conditions for applying the marginal theory (perfect competition) tend to be less satisfied.

(3) If a significant input is omitted from the estimating equation, depicting the production function, the resulting estimate of marginal productivities would be biased.

For the present study, to calculate the marginal productivities and the efficiency of the use of these factors contributing to cotton production in Gezira, it means that land, picking labour, insecticides and fertilizers should be considered. All appeared in the selected estimating equations in table (5.3.2) above except fertilizers which proved to be a significant variable influencing cotton yields (equation no. 5.3.24, table 8, Appendix B).

One would, therefore, need the respective prices or opportunity costs of these inputs. But this is not feasible with the data at hand.

Market values of land in the Gezira scheme are suppressed at pre-development rent since the inception of the scheme and for 40 years. For providing the land, the government gets a share in the proceeds of cotton. This share covers, beside land, al: the other factors that are concealed under the land factor (e.g. irrigation). Ideally, the annual actual rent would represent the services of land input. But this can not be defined and imputed without much ambiguity in the conditions of the Gezira scheme. The second variable for which no price is available is picking labour. As mentioned before the productivity of this variable is expected to be fairly close to the wages received, in particular those paid per piece (Guffa of picked cotton). Moreover any increase of this factor would alleviate the shortage experienced during the picking season when pickers are the major constraint. Yet attempts to evaluate their productivity would not have been out of place if data was available. The only remaining economic variables on our list of the factors influencing cotton output and yield in Gezira are fertilizers and insicticides.

The analysis would be confined to these two factors for which fairly adequate information is available. Moreover both fertilizers and insecticides are relatively easy to adjust especially in Gezira's situation where they are decided for the whole scheme from the centre; management. The calculations of their marginal productivities and relative efficiencies is based on equation no. 5.3.24, table 8, of Appendix B for cotton yields. The choice of yield function, where both factors prove influencial to yield variation, is in order to provide a useful yardstick which enables recommendation to be for per unit use (per feddan).

Table(5.3.4) Marginal productivity of fertilizers and insecticides in Gezira scheme 1950/51-1963/64 (equation no. 5.3.24 Appendix B)

(1) Input	(2) Elasticity w.r.t. yield per feddan	(3) Average prod. (K.p.f.)	(4) (2x3) Marginal product (K.p.f.)	(5) Deflated average costs per feddan L^s	(6) Net return per Kantor of cotton (Rev. - variable cost with Yield) L^s	(7) (5÷6) Minimum increment in yield to break even (K.p.f.)
Fertilizer	0.4426	2.045	*0.9	2.121	+ 10	0.2.
Insecticides	0.5826	4.878	2.9	0.889		0.09

K.p.f. = Big Kantor of unginned seed cotton per feddan.

* Estimated at arithmetic mean input levels

\+ Based on average deflated F.o.b. price of ginned ELS (Sakel) cotton for 9 years between 1955 and 1963. The average price used amounted to L^s 15.80.

Despite their tentative nature the estimates seem to be quite revealing and suggestive. They provide evidence that both fertilizers and insecticides are among the modern inputs, the adoption and effective use of which would raise cotton yields in Gezira. This potential is exhibited by the difference between the results of the present level of application and the minim required to cover a unit of additional cost involved (Col. 4 and 7 of above table). As the point of optimum (m.r. = m.c.) seems not to be attained for the use of those imports in Gezira scheme, their quantities could be profitably increased beyond the present levels.

In our calculations, however, optimum quantities or their equivalents were not computed. This would not have been of much practical use as in conditions of capital scarcity, to which Gezira is no exception, what is required is not the equilibrium quantities of the inputs simultaneously maximizing profit (m.r. = m.c.) as much as the input quantity which would maximize the rate of return on investment in those inputs (equal in all uses).(1)

In their reports(2) on development agriculture in Gezira, the working party attempted to evaluate the use of fertilizers and insecticides in the scheme. Using data pertaining to a single year (1962/63 for insecticides and 1964/65 for fertilizers), they estimated the minimum additional product to cover an additional unit of the costs involved per feddan as 0.2 and 0.06 k.p.f. for fertilizers and insecticides respectively. The results seem to be in agreement with those of the present study given in Col. 7 of table 5.3.4 above. The differences between the two estimates remain though they do not invalidate their agreement.

The working party's estimates are based on a single year's data in each case, 1962/63 and 1964/65, while the present study is based on a time series covering the period between 1950/51 and 1963/64. Both the single years used by the working party fall, more or less, within our period of study as not too much change has taken place in use of these inputs up to 1964/65. Our analysis

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(1) Heady & Dillon, Agricultural Production Functions, 1961, p. 46-57.

(2) Working party, Interim report, April 1965, p. 129.
Final report, 1966, p. 82.
Ministry of Agriculture, Khartoum, Sudan.

used multiple regression where the resulting estimates have been subject to statistical significance tests and marginal products are derived at the mean values of the respective inputs. The price of cotton we used is for ginned lint cotton and did not include the joint product; cotton seeds, the value of which undoubtedly increases the net return per feddan of cotton. The working party's estimates, on the other hand, seem to be based on lint price alone for fertilizers while on lint and seeds for insecticides. Finally we believe that our estimates are downward biased. The costs, variable with increments in yield (marginal costs) because of using the additional input of fertilizers or insecticides, are deducted arbitrarily. The average deflated lint price we used was L^s 15.80 for the period between 1955 and 1963. Though it did not cover the whole period under investigation 1950-1963, it is not an unreasonable approximation since it represents the average of 9 years out of the 14 years' observations considered. Cotton prices during the 5 years for which data were not available (1950-1955) were higher than the later years of the study, a fact that would have made the average cotton price for the whole period higher than the one used in the estimates.

Out of this average cotton price L^s 15.80, the variable costs were arbitrarily taken on the average as L^s 5.80. The net return, to which the minimum required to cover the unit of costs involved for both fertilizers and insecticides came out as L^s 10.0 as is shown in table (5.3.4) above.

With all these considerations in mind, the empirical evidence suggests that both fertilizers and insecticides are below their optimum use in cotton production in the Gezira scheme. If those inputs are increased and effectively used in Gezira they would favourably influence cotton output. Moreover the increasing use of these variable resources would increase the elasticity of supply and make any desirable adjustment feasible i.e. shifting the emphasis towards more intensive cultivation than what has been the case during the period of study.

SUMMARY

The following is a summary of the main findings scattered in the text during the course of discussion of the results:-

(1) The growth of output of ELS cotton during the period 1945/46 and 1963/64 was mainly due to extending the area under cotton. It is during this period that most of the private estates and the Managil extension to Gezira scheme came into existence.

(2) Concentrating on Gezira, to which the major part of the analysis attempted in this section was devoted, the evidence suggests that the contribution of the land factor to cotton production is relatively lower during the sub-period 1950/51-1963/64 than before.

(3) Nearly the same set of explanatory variables which accounted for the variation in total output (Y) turned out to be responsible for variation on per feddan ($\frac{Y}{A}$) level as well during the period 1950/51 to 1963/64. These are land, picking labour, rainfall and insecticides.

(4) Rainfall proved to be of significant influence on the whole ELS cotton sector as well as in Gezira scheme. Examining the Gezira estimates, the findings suggest the following: Total current rainfall (W_t) seems to be more important when taken with the insecticides variable than representing the influence of rainfall by the previous year's total rainfall (W_{t-1}) and presowing rains (W_s). In other words, the result questions the way the rainfall influence used to be measured. This is supported by the fact that no significant positive correlation was found between expenditure on insecticides and the previous year's total rainfall variable (W_{t-1}) so as to make us accept that the relation between them is proportional.

(5) No estimates were possible for the family labour component in Gezira because of the difficulties encountered in its measurement. Those attempted were only for hired (picking) labour which represents more than 50% of labour requirements. This variable proved to be of marked significance on both cotton output and yields.

(6) Fertilizers and insecticides turned out to be significant variables favourably influencing cotton yields. During

the period between 1950/51 and 1963/64 there seems to be a disequilibrium in their use. Judging by their computed marginal products and respective returns the present rate of applications is below optimum.

(7) The management factor is believed to be one of the factors favourably contributing to cotton production in Gezira. This has not been evidenced except in one out of all the estimates attempted. Most possibly intercorrelation impaired the significance of this variable. The favourable result obtained should only be accepted in the context of the quality of the management factor (especially field staff) and the changes that took place during the period of study. There is reason to believe that the significance of this variable could be profitably increased if the quality is improved and the emphasis of the role played is reviewed.

(8) Taking into account the way the tenancy size variable was measured, no evidence is substantiated from the analysis that the reduction of cotton tenancy size is favourable for increasing cotton production in the Gezira scheme in general. On the contrary, it seems that the indirect effects of reduction of size of tenancy, manifests in low incomes generated, create a disincentive for mobilizing more of the tenants ability and willingness to grow cotton.

(9) ELS cotton sector turned out to be operating under diminishing returns to scale. As this was contrary to what was expected, it was difficult to accept without better specifying the production function relation. This was only possible by checking the estimates of Gezira where more of the variables omitted in the aggregate function are available. The result showed that Gezira (biggest cotton scheme) is operating under increasing returns to scale.

Chapter Six

Pricing Policy

The objective of this chapter is to review the pricing policies of Sudan ELS cotton, compare the underlying hypothesis with those suggested by economic theory for similar market situations and finally to test empirically the validity of those hypothesis.

I Mechanism of Price Determination

Sudan cotton prices have experienced different methods of price formation. These are part of the marketing policies reviewed in Chapter III and mainly developed for public sector cotton (i.e. Gezira):

(a) Up to 1953

During the early days and until the adoption of the auction system in 1953, the following were the major practices:

(i) Auction price: when all cotton was shipped to the selling agent, B.C.G.A., at Liverpool, Sudan cotton prices were those fetched in the auction.

(ii) Cost plus: This was during World War II when the Cotton Central Commission bought all Sudan cotton at prices fixed on the basis of the items included in the Joint a/c[1] of cotton production in the Gezira schemes.

(iii) Alexandria spot quotations: On basis of these quotations in November each year, the Royal Cotton Commission bought Sudan cotton on a renewable contract basis between 1948-1952.

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(1) Joint a/c: All items involved in producing the crop except labour costs which are the responsibility of the tenants.

(b) Reserve Price: (1953-)

From 1953 and with the adoption of the auction system, cotton is offered to the auction on a "minimum reserve price". As this procedure is the one which prevailed during the period of this study (1953-1965) more consideration will be given to it.

There are two factors that characterize Sudan cotton marketing and exert some influence on its price formation:

(1) Sudan cotton marketing season starts in February each year while the World cotton marketing season begins in August. More important is that the marketing season of the similar growth, i.e. Egypt ELS variety, begins in August-September as well.

(2) The declining significance of information flowing from cotton exchanges, as previously, due to the interventionist policies of U.S. and U.A.R. which closed finally the Alexandria cotton exchange for Egyptian cotton in 1959. The Liverpool cotton exchange, on the other hand, does not maintain its pivotal position at the centre of the cotton trade as it used to traditionally. It is losing its locational importance with the cotton textile industries shifting away from Western Europe.

Sudan cotton authorities faced with this situation saw it to the interest of the country to set a minimum reserve price for starting the auction. Buyers who offer their bids call for grades they want from the auction list and start their bids by the minimum reserve price set for each grade.

Definition of reserve price:

It is maintained that reserve price is an indication of the "fair" value of Sudan cotton. It is determined after close examination of the internal cotton trade situation as well as price trends in foreign markets and major cotton exchanges. (New York, Liverpool, Bombay, etc.).

The authorities (Gezira) made it known that the reserve price was not a guaranteed minimum price nor a support price. It does not interfere with the market forces. Rather it helps to ensure the efficient working of the market and eliminates speculative and imperfect actions in a situation where price information is scanty.

It is reviewed before each auction in line with the latest price trends and cotton trade conditions.

The reserve price was a declared price before bids were made. This continued from February 1954 until January 1959 when a switch to undeclared price took place under the conviction of not interfering with the market mechanism.

However, this reserve price has been a source of buyers complaints when their bids are rejected as not attaining the minimum fixed. This has been especially so with the undeclared reserve price.

On the other hand the inflexibility of the fixed minimum reserve price imparted its adverse effects on the producers' interest in 1954, 1958, and 1965 marketing seasons when the reserve price was set at levels that failed to change in response to market price. Cotton was held off the market and sales were effected at even lower prices than earlier, resulting in less proceeds and delayed marketing.

II Economic Theory and Sudan Cotton Pricing

On the assumption of profit maximization, economic theory suggests that equilibrium is attained by equating marginal costs and marginal returns. The resulting price is the equilibrium price which in the short run may be different from the normal price. The latter is the long run trend around which the market price fluctuates. In the long run where all costs are variable, marginal revenue is equated to marginal total cost, while in the short run the entrepreneur maximizes his revenue by adjusting his variable costs so that marginal revenue is equal to the marginal costs.

The above is an outline of the perfect competition model based on the marginal analysis of market equilibrium. Perfect competition is only one type of market out of several, classified according to the nature and characteristics of each.(1)

Of the five market classifications the marginal theory is applicable to three of them, leaving out oligopoly and monopolistic competition with monopoly as special cases. Attempts, however,

(1) Those are: perfect competition, perfect monopoly, monopolistic competition, oligopoly and monopolistic competition with monopoly (competition among the few).

were made by J. Robinson, Chamberlin and Fellner to generalize the profit maximization model by extending the marginal theory to the special cases. The essential difference between these oligopolistic market situations, on the one hand, and the perfect competition model and monopolistic competition, on the other hand, lies in the interdependence of sellers' actions rather than homogeneity of the product or number of sellers alone.

The Sudan cotton market is believed to approximate to such oligopolistic situations. It is a case of competition among few producers who produce almost the same product, ELS cotton variety. As referred to earlier in Chapter IV, Sudan and Egypt produce over 70% and export over 90% of world totals. The rest is mainly shared between Peru and U.S.A. The behaviour of the market under oligopolistic conditions has been discussed on different theories and assumptions. Of these, the "collusive solution" is elucidated[1] hereafter.

This is known as Fellner's solution to the oligopolistic market in terms of marginal theory.[2] While he rejects complete independence of action on pricing by individual firms in an oligopolistic market, he does not see that such an interdependence hinders individual action on behalf of the others which may not lead to price war. Such quasi agreement between businessmen will lead to a sort of maximization of their joint profit which is an axiom of the marginal theory.

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(1) Henderson & Quandt, Microeconomic theory, 1958, Chapter (6).
(2) Andrews, P.W. On Competition, 1966, p. 44-46.

The individual initiative to act on behalf of the group in a way acceptable to all of them is determined by the strength of the firm and her position in the market. Differences in firms' costs confer upon them these positions in an oligopolistic market. Therefore the firm that is likely to take the initiative in an oligopolistic market would be a big and low cost firm.

Gaining this position of (strength) leadership, the low cost firm sets a market price for herself chosen from the alternatives open to her but optimizing her results and does not provoke retaliatory reaction from followers. Followers, on the other hand, in terms of their positions and shapes of their demand curves in their particular markets accept the leader's price and follow suit. By this they do better than with divergent actions from the leader's.

III. <u>Testing the hypothesis underlying Sudan cotton price formation</u>

The formation of Sudan cotton "reserve minimum price" is not known except to Gezira authorities; the responsible body. All that is given is that it represents the "fair" value of Sudan cotton according to each grade enlisted to the auction. It is based on the internal cotton situation as well as price trends in major cotton exchanges abroad. Buyers who offer bids less than the reserve price will not be able to get their requirements from the auction cotton. Reserve price is undeclared.

From this and Sudan price quotations at Liverpool, a hypothesis can be formulated to test the assertions made by Sudan cotton authorities about pricing of the crop. The test will be directed towards the following two questions:-

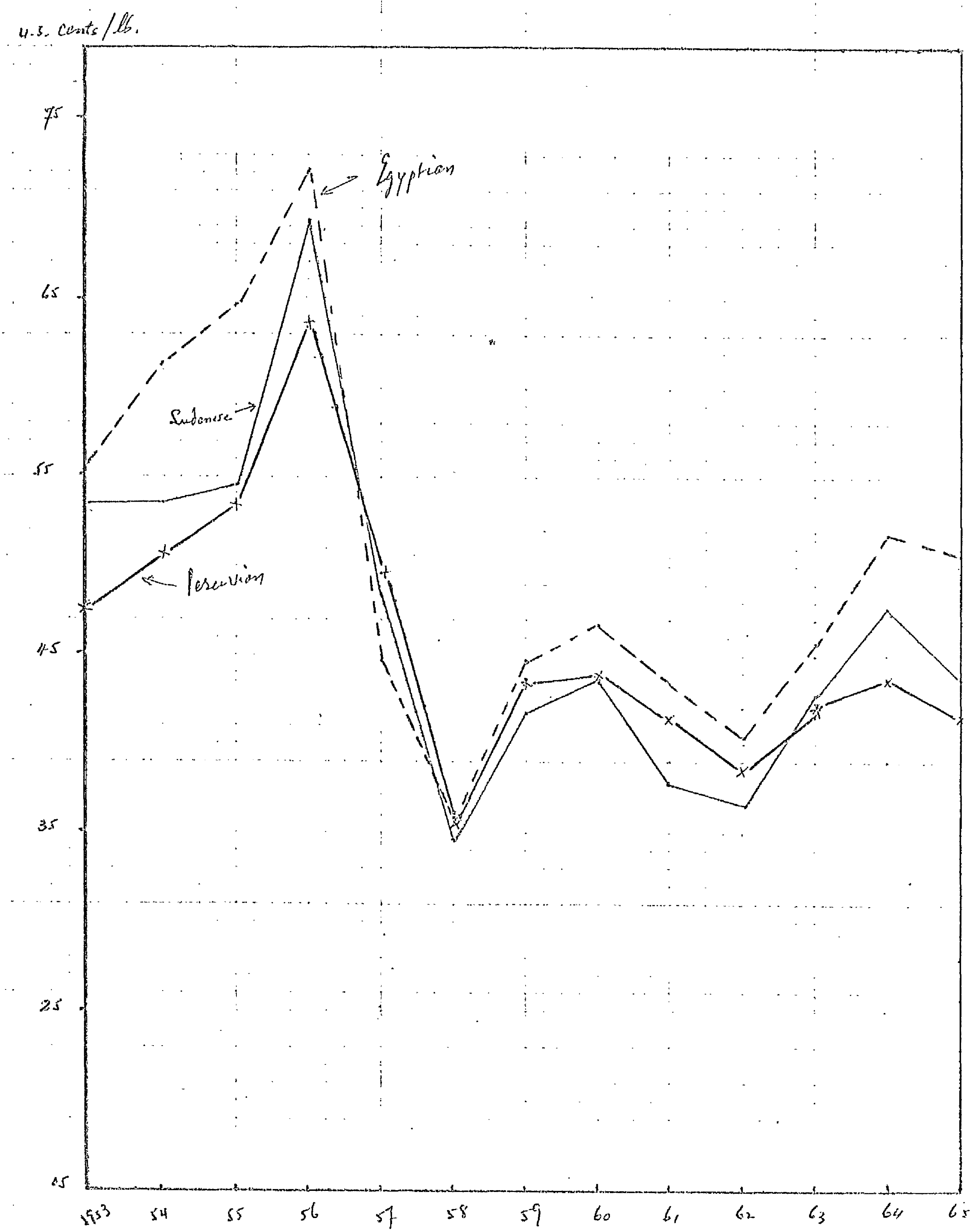

Chart (6.1) Liverpool price quotations for ELS cotton of Egypt, Sudan and Peru

(i) Is Sudan cotton pricing market oriented? i.e. Demand based price.

or (ii) Is it internal cost oriented? i.e. cost plus and to what extent?

The significance of the answer obtained can only be understood in terms of the pricing policy objectives of Sudan cotton. Knowledge of this would help in framing the conclusions of the analysis which will be judged by principles of economic theory as outlined earlier.

In his survey for large industrial corporations (U.S.), Lanzillotti,[1] gives the following classifications as the various pricing objectives of these firms:

(1) <u>To achieve a target return on investment</u>: Therefore the company follow a predetermined rigid goal over the investment period. This method is not different from the cost plus principle which is a step towards investment rate of return. If the pre-determined goal of the company is rigid and incompatible, an investment target return may contradict the market share objective.

(2) <u>Market share</u>: Pricing policy may be drawn so as to ensure the company's share in the market.

(3) <u>Matching or meeting competition</u>: This objective is influenced by the firm's market share and position in business.

Reverting to Sudan cotton, it is difficult to say which of these or other targets the pricing policy aims at. It would be equally difficult to say that it aims at all of them, in the absence of a particular preference freely opened to Sudan.

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(1) Lanzillotti, R., "Price objectives in Large Corporations", p. 63-83, <u>Price Policies and Practices</u>, Mulvihill and Pranka, (ed.), 1967.

Sudan cotton industry during the period under study 1953-65 (public schemes in particular) has absorbed quite a lot of foreign loans invested in extending the area, the irrigational network and other ancillary assets that increased the capacity of the industry. To repay these debts a target return policy cannot be ruled out. Meanwhile Sudan has to keep and expand her market share: particularly as Sudan relies entirely on export markets for her cotton crop. Added to these two constraints; securing a target return and an increasing market share, is the growing competition for Sudan cotton variety ELS. It is this variety of natural apparel fibres that suffered most from both other short staple cotton and man-made fibres. This difficulty is multiplied for Sudan by losing her traditional major market (U.K.) where most of her cotton trade was concentrated.

However, these intermingling aspects of a pricing policy for Sudan cotton does not mean that an adopted objective would necessarily sacrifice some others.

A distinction, at this juncture, is necessary between the short run and the long run. For the long run all costs are recovered. The feasibility of this is foreseen when the investment capacity is planned. This can be reviewed and reconsidered according to the long run trend of the industry in question. On the other hand, the short run considerations are different and some divorce from the long run sunk costs takes plac The emphasis is on the variable adjustable costs when reallocating all the costs, variable and fixed, becomes difficult.

The long run consideration that dominates Sudan cotton policy is that cotton is the remunerative cash crop so far. On this basis the cotton industry's capacity has been extensively expanded with foreign loans. Yet it is in the short run that most of the difficulties and policy problems arise. One of these is the reliance on cotton export proceeds to a large extent. Sudan cannot cope with any adverse consequences resulting in low or delayed proceeds.

For example, the Government revenue depends on her share in cotton proceeds from the publicly owned schemes and the import duties. In the fiscal year 1963/64 the contribution of these two items was 9.9% and 35.6% respectively.(1) More significant is the role of cotton exports in financing the import bill. Cotton accounts for over 50% of foreign earnings.

The foreign reserves of Sudan are not adequate to cushion any deficit arising from cotton proceeds. This is due to the fact that Sudan was among the few primary producers who failed to accumulate large reserves during the Korean boom. Moreover, expanding development expenditure puts a heavy strain on the available reserves which itself is a function of cotton proceeds. In his study of export instability McBean(2) showed that Sudan was the first of the only two countries (Iran) which had significant correlation between fluctuations in export earnings and foreign reserves of all the ten countries considered.

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(1) Economic Survey, Ministry of Finance and Economics, 1964, p. 53.

(2) McBean, A. Export Instability and Economic Development, 1967, p. 84.

The impact of cotton proceeds on other sectors is immense. Tenants have to be paid. Loans borrowed for the previous crop should be refunded and the financing capacity of credit channels is limited. All these factors point to one fact: immediate cotton proceeds and marketing of the crop at reasonable price.

Empirical evidence

With the above theoretical considerations and the special position of cotton for the Sudanese economy, the criteria of price determination will be tested. This will cast some light on the dissatisfaction of buyers about the reserve price of Sudan cotton and to what extent it conforms to market prices.

Variables: (P_s), (P_e), (P_p) and (P_a) are Liverpool quotations for Sudan, Egypt (ELS) Peruvian (ELS) and American medium short staple cotton respectively.

C_1 = all costs shown in the joint a/c of Gezira Scheme for lint and cotton seeds. This variable is chosen for Gezira as it represents the administering agent which sets the minimum reserve undeclared price. Besides, Gezira supply almost all the cotton offered in the auctions.

C_2 = all costs of joint a/c less cotton seeds expenses. The reason is that the Liverpool cotton price (P_s) is for lint cotton and therefore if any relation exists, it would be between such price and the proxy variable of all lint cotton produced.

(C_1) and (C_2) are the items on the debit side of the joint cotton a/c representing (the variable costs + depreciation).

S = all stocks of cotton in Sudan. Though this variable as used, may show some upward bias, as it stands for stocks at 1st August which is the middle of the Sudan marketing season, account should be taken of the stocks of ELS in other producing countries at the time Sudan prices are determined. For this reason no adjustment is made as there are no figures on cotton (ELS) stocks in other countries. The high estimate of Sudan stocks is taken as a rough approximation.

Estimate:

The relation is expressed in linar equations of the type

$P_s = a + b\,P_i + u$

P_s = price of Sudanese ELS

P_i = (i = e, p or a) prices of Egyptian, Peruvian or American

u = error term.

Out of the various multiple regression equations fitted, the following was obtained as best fit for (1953-65) and (1953-63) respectively:

	$\bar{R}^2$	$\frac{\delta^2}{S^2}$
(6.8) $P_s = -6.6068 + \underset{(0.1641)}{0.3583}\,P_e + \underset{(0.2231)}{0.7744}\,P_p - \underset{(0.00471)}{0.00031}\,S_t$	0.94	1.671
(6.15) $P_s = -15.5383 + \underset{(0.2763)}{0.0995}\,P_e + \underset{(0.3604)}{1.0932}\,P_p + \underset{(0.2471)}{0.2222}\,P_a - \underset{(0.00886)}{0.00101}\,S_t + \underset{(0.00091)}{0.00013}\,C_2$	0.94	2.424

The inclusion of (P_a), (S) and cost variables (C_1, C_2) does not improve the result obtained by taking only the prices of Egyptian (P_e) and Peruvian (P_p) as the only explanatory variables. Though these variables (P_a), (S) and (C_1, C_2) are statistically insignificant, they retain the expected signs which indicate that the price of Sudan cotton tends to rise with increasing costs, price of American cotton and smaller stock figures.

The crucial variables which account for most of the variations in (P_s) are those of the similar growths (ELS) of Egypt and Peru. But the fact worth mentioning is the relative importance of the Peruvian (P_p) quotations in determining Sudan prices (P_s). According to equation (6.8) above, both (P_e) and (P_p) are significant at 10% and 5% levels respectively. At this level of significance a 10% change in either (P_e) or (P_p) will cause 6% and 7.5% change in (P_s) in the same direction at the mean value of the price variables respectively. And in equation (6.15) the Peruvian price (P_p) is the major significant independent variable in the relation. Its regression coefficient indicates a more than proportionate change in the price of Sudanese when the Peruvian price changes. The rate of change is (1.1) at the mean values of (P_s) and (P_p) and is significant at the 5% level.

The net result from the two equations analysed above is that Sudan cotton price formation is highly related to the Peruvian (P_p), to a lesser degree to the Egyptian (P_e) and very slightly to American (P_a) stocks and cost variables during the period of study 1953-65.

According to the conditions of oligopoly, Egypt is expected to set the price while both Sudan and Peru follow suit. Egypt is the biggest producer with the lowest cost. Yet the higher correlation between the Sudanese ELS cotton price and the Peruvian Pima price than its counterpart between Egypt and Sudan, can be explained on two grounds:

(1) Either Sudan is not following the position as indicated by oligopolistic theory of being a price taker as it is set by the leader (Egypt),

or (2) the grades of Sudan extra long staple cotton have been of lower quality than those which Egypt exported during the period of study. Therefore they commanded higher prices than those of both Sudan and Peru.

In fact, no single answer could be drawn without taking account of both factors mentioned above. During the period of study 1953-65, ELS cotton trade experienced drastic changes made by Egypt. Alexandria cotton exchange was subject to control until it was finally closed. Egypt diverted her cotton trade to the East from the Western market. Accordingly, market information provided by Liverpool cotton exchange for ELS cotton was less and less effective. Added to all these, is the U.S. cotton policy which makes the price less free and subject to market forces. Under these circumstances Sudan minimum reserve price was adopted to help and guide auction transactions.

The only price quotation for a similar growth in the Western markets to which Sudan mainly exports, is the Peruvian. It is in direct competition with the Sudanese in these markets.

On the other hand, the variation of ELS grades of cotton exported from both Sudan and Egypt may be responsible for the price differential and the resulting relatively lower correlation than with the Peruvian.

Cotton grade is determined by a host of factors: length, strength, lustre and cleanliness. Sudan cotton ELS grades in this context have been varying considerably with a tendency of over 50% concentration in the lower grades. According to Sudan Gezira classification, grades of ELS produced in Sudan gave the following results[1] which indicate this tendency of lower grades content for the years 1950-64:

	1950-54	1955-62	1962-63	1963-64
Grade 5 and lower	81%	59%	17%	59%

However, the situation can be summed up as follows: Sudan cotton price formation is influenced by both Egypt and Peru prices though the latter's effect is more significant. When both are introduced together with other independent variables the price of Peruvian cotton assumes all the influence from other variables in the relation including the Egyptian price as well. The reasons are either statistical, due to the strong correlation between the two explanatory variables (P_e) and (P_p), or economic. For economic aspects Sudan might have had the chance of determining her cotton prices during the period of study, for a large part of

(1) Compiled from: I.B.R.D. Report on ELS cotton, Appendix 4, p. 10. (Years 1950-54, 1955-62), Economic Survey, Sudan Government Ministry of Finance and Economics, 1963, 1964 (Years 1962/63, 1963/64).

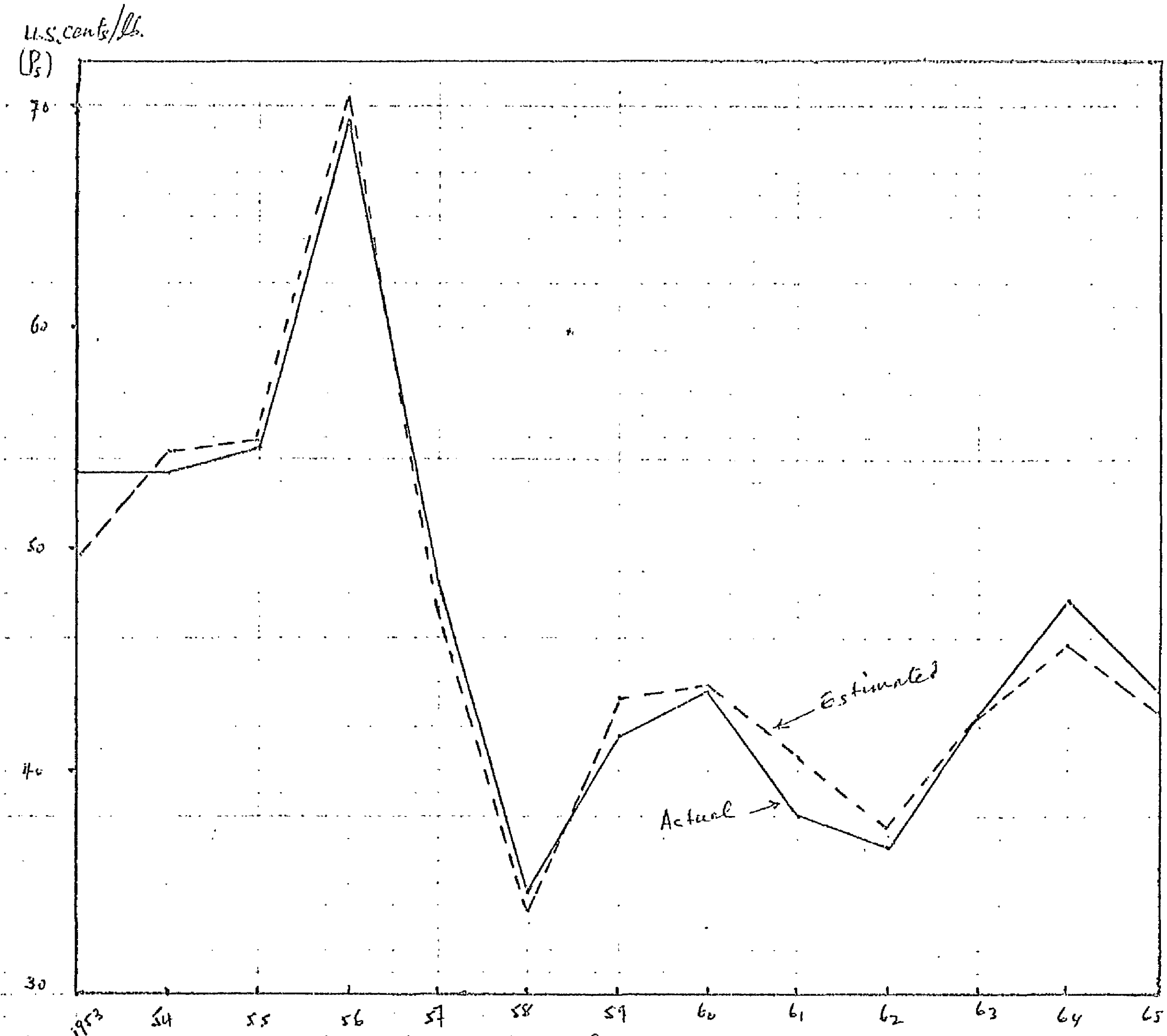

Chart (6.2): Actual vs Estimated
Sudan ELS Cotton price
(equation no 6.8)

which Egyptian cotton was completely diverted to the East. Although ELS cotton was not in relative shortage, Sudan cotton prices were set in relation to price quotations for similar growth prevailing in Western markets (Liverpool). The tendency to accept the Peruvian price as representing these quotations reflects the possibility of Sudan prices being less than the Egyptian sold in the West because of lower grades content than the Egyptian.

Such a conclusion, however, does not invalidate the results obtained in the previous chapter on demand functions where the Egyptian variety of ELS was taken as the close substitute for the Sudanese in the markets considered. On the contrary, taking the Egyptian growth instead of the Peruvian is based on the belief that while both are the main close substitutes for the Sudanese, the potential and stronger close competitor is the Egyptian. Egypt is the principal producer with the lowest cost which gives her a leading role in an oligopolistic market of ELS. Also the significance of being a potential competitor, even stronger than at present, is envisaged from their intention to return to the Western markets thus creating a permanent threat to the Sudanese. This is decided upon after having largely consigned their cotton exports to the centrally planned economies of Eastern Europe. In his statement on the cotton policy for the year 1965/66 the Egyptian Minister of the Economy and Foreign Trade referred to this return and to a less interventionist policy in future.[1] However, the fact remains that U.A.R.'s large debts[2] to U.S.S.R. and the convenient method of repaying through cotton exports raise some uncertainty about these intentions embodied in the cotton policy of Egypt.

The conclusion therefore is that Sudan cotton pricing is market-oriented. Despite an element of inflexibility in the system and rapid adjustment of the reserve price, the price quotations prevailing in Liverpool follow the trend of the similar growths of Egypt and Peru. Resort to a minimum reserve price by the Sudanese cotton authorities is not so much an interference with the market as a guide for auctioneers where price information is scanty. By making the reserve price declared before the start of the auction, the Sudanese cotton authorities insistence about the role of the reserve price will be confirmed to the dissatisfied complaining buyers and bidders. During the period of study evidence was given that prices were market-oriented. Co-ordination with other producers (i.e. Egypt) may help in making the reserve price a declared one.

SUMMARY

(1) The price formation of Sudan cotton is market oriented and is not internal cost oriented. This means that Sudan cotton follows the market quotations of similar growths, as has been proved empirically, and is not priced solely according to costs incurred already. Of the similar growths, Sudan cotton prices showed more correlation with the Peruvian than the Egyptian. The explanation is due to many possible factors:

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(1) Hassan A. Zaki, "Outlook on Our Cotton Policy", p. 68-69, Rose-El. Yossif. (Special cotton supplement) Weekly Magazine No. 2008 (1966).

(2) F.A.O. Indicative Plans for Agricultural Development, 1965-85: Near East (Prov.) Vol. I, p. 60.

(i) The disappearance of Egypt's cotton from Western markets to the East. Thus Liverpool quotations were of less help as price information since Sudan cotton sold during that period was of lower grades and commanded a lower price nearer to the Peruvian than the Egyptian.

(ii) The Peruvian quotation is the price information available and useful when the marketing season starts in Sudan on which, with Egypt's interventionist policy, more reliance is placed.

(2) Sudan cotton reserve price, the source of buyers' complaints, is not an interference with the market. Though it was undeclared, the empirical test on the price quotations against which bids in the auctions were accepted (starting from reserve minimum price) showed closer adherence to the market price of other cottons than to the costs of production in the Gezira scheme.

(3) Though Sudan pricing follows market quotations, it does not strictly fit the oligopolistic conditions of the market by following the leader's price that maximizes the joint profits of the competing oligopolistic producers. The divergence between leader's price (Egypt) and Sudan's price is referred to in (1) above.

On the whole, one can say that Sudan tended to set her price in broad terms with the leader (Egypt) during the period of study by which time Egypt's cotton was committed to the East. This tendency was confirmed by two incidents when Sudan stuck to her reserve minimum price, rejecting bids made at the auction closer to the Egyptian reduced price quotations. The consequences were grave as the cotton was held off sale and later was sold at even lower prices (1957/58).

(4) With Egyptian cotton returning to free trading as declared in their cotton policy 1965/66, the competition will be more fierce. The ability of Sudan to deviate from price quotations is limited by her resources, her need for immediate sales and the key position of cotton proceeds.

Chapter Seven

SUMMARY, DISCUSSION AND CONCLUSIONS

As the main results obtained are summarized at the end of each chapter, they will be broadly outlined here before discussing their implications on certain policy issues.

It needs to be emphasised, however, that because of the empirical nature of the study, necessary caution should be taken when the results are interpreted and used. The accuracy of the estimates and the conclusiveness of the results, are, by and large, determined by the quality of data used and the computational procedures applied.

Having established the fact that Sudan's exports proceeds are subject to a relatively high degree of instability, higher than the average developing country exporting primary products, and that the main causes of this instability are attributed to specialization in primary production with high degree of commodity concentrates (extra long staple cotton), the study set out to investigate the basic relationships of demand and supply of this single crop. The objective is to provide more insight into the factors underlying these relationships and their impact on policy decisions concerning ELS cotton, the backbone of the economy.

The empirical evidence suggests that world demand for ELS cotton seems to be inelastic (- 0.8). This elasticity indicates that the demand is much more elastic than it used to be in periods preceding the period investigated here (1953-1965). The results obtained explained this as a manifestation of the growing competition between ELS cotton on the one hand and short staple cotton and man-made fibres on the other. Estimates of demand functions for five of Sudan ELS cotton export markets (U.K., France, W. Germany, Italy and India), show that Sudan ELS cotton demand has a markedly high elasticity with respect to price. Except for U.K., the estimates obtained were: France (-3.0), W. Germany (-6.8), Italy (-13.5) and India (-5.7). Together with the significant estimates of cross elasticities with similar growths (Egypt's) and man-made fibres, the results reflect the extent of the keen competition Sudan cotton is facing in these markets. This is believed to be the outcome of loosing the traditional export market of U.K. where Sudan concentrated her exports until recently and the subsequent efforts made to redirect her cotton trade.

In doing so, Sudan did not seem to strictly follow the oligopolistic model explaining the market behaviour to which the Sudan ELS cotton market is believed to approximate. In pricing her cotton, the results suggest, Sudan did not closely follow the actions of the leader (Egypt) who is the largest producer with lowest costs. Testing the formation of "reserve price" from series of observed[1] actual prices the result shows that it does not seem to depart from market information of similar varieties (e.g. Peru).

The analysis of the supply side on the other hand showed that the institutional organization of the cotton sector imparts certain rigidity to supply response. From results obtained for Gezira scheme and using the distributed lag adjustment model, the supply of cotton is very inelastic in the short run and relatively elastic in the long run. The long run elasticity increases the more one allows for lagged effects, a clear manifestation of the institutional rigidity and other constraints. Attempts were made to estimate tenants (cotton

(1) During the period of analysis "reserve price" remained undeclared to bidders at the auction.

growers) supply response. Despite the fact that the institutional rigidity limits the rationale of estimating the responsiveness of tenants to economic incentives, the results obtained for the Gezira scheme suggest that tenants respond to economic reward by putting more effort into cotton production. This is revealed by the relation between cotton yields and the income share accruing to the tenants.

The inquiry into the factors contributing to production and cotton yields in the ELS cotton sector suggests the following:

(1) Aggregate ELS cotton production in Sudan is influenced by land input and rainfall. The effect of the land input is, however, believed to be over-estimated as the "irrigable acreage" conceals the effects of the other variables not included in the analysis because of difficulty of measurement.

(2) In the Gezira scheme where more data was available, estimates for 1945/64 and 1950/64 showed that land, rainfall, hired labour for picking, insecticides and fertilizers are the significant factors that turned out to account for output and yield variation.

(3) The influence of the management variable did not show up in any of the basic estimates chosen for the discussion. Yet it proved to be of some significance in one estimate only.

(4) Some of the factors in Gezira are believed to be below optimal use. This is illustrated by the calculated marginal productivities of both fertilizers and insecticides.

(5) The ELS cotton sector is believed to be working under constant returns to scale. This conclusion is based on the significant increasing returns to scale obtained for the Gezira scheme.

The result of diminishing returns to scale obtained for the whole cotton sector was therefore discarded as it was based on an inadequately specified relationship in the absence of relevant data.

In context of the outline given above for the results of the statistical analysis attempted, some of the policy issues concerning ELS cotton will be discussed as follows:

(a) Issues in ELS cotton production and institution policy

(i) Adjusting ELS cotton supply to long term trend

From chapter IV it has been shown that consumption of cotton as an apparel fibre has been declining in relation to total consumption of textile fibres. More important is the conclusion suggested by estimates of cotton demand functions that cotton, in general, is no longer a non-inferior industrial raw material in some markets of Western Europe. This together with the inelastic world demand obtained for ELS cotton and the increasing competition from short staples and man-made fibres, indicate that the long term trend of ELS cotton commodity is declining.

Sudan has vastly increased her acreage under ELS cotton during the period of study. The overriding criterion was that ELS cotton is the most remunerative crop. Targets were set in the Ten Year 1960/61-1970/71 Development Plan to expand the acreage under ELS cotton to one million feddan (against 740,000 feddan in 1963/64). These expansions are being completed at rising costs. Because of the institutional rigidity and absence of other alternative crops, areas brought under cotton are bound to remain under cotton with limited chances of adjustment to the declining trend. Under such circumstances and in view of the inelastic demand it seems necessary that the long term policy should be geared towards adjusting ELS cotton supply to the market demand. This would mean no more expansion of the areas under cotton with the present conditions of demand and competition. Resources should be directed to other uses.

But this might seem unwise if the profitability of the cotton crop as compared with other alternatives at present is considered. The concept of profitability needs to be widened to include other less profitable enterprises in comparison with cotton. Judging by the present situation where cotton is the only cash crop, most of the causes of instability of export proceeds are attributed to the vulnerability of cotton and its violently fluctuating yields. These short-run fluctuations, undoubtedly, should be taken into the profitability of the long run. It has been shown in chapter one that countries with more than one export cash crop are subject to a relatively lower degree of instability.

Thus limiting the area expansion and diversifying with other crops is believed to be more effective in reducing the instability of export proceeds arising from dependence on ELS cotton alone. The big potential that Sudan seems to enjoy for expanding the acreage under ELS cotton is possibly reduced by the rising costs of cotton production. The competitiveness of Sudan depends mainly on cost reductions whether with respect to other producers or other textile fibres. Emphasising on more intensive measures to increase ELS cotton production would most likely reduce the costs more than extensive cotton production dependent on expanding the acreage under cotton. From the production function analysis it has been shown how cotton yields could be favourably influenced by using more fertilizers and insecticides. The results suggest that they are below optimum use. Yet under conditions of expanding the acreage to increase cotton production their use could not be increased without considering the overall effect on market conditions and cost reductions. At present, and with the prevailing levels of application there are already tendencies of disequilibrium between cotton demand and supply. But if acreage expansion is limited, or even more, ELS cotton is confined to the best areas with higher yields, intensive cultivation with optimal use of these inputs may lead to increased production and productivity with significant reductions in costs. Moreover, use of more variable resources will increase the elasticity of supply and make the adjustment more feasible and rapid when necessary.

(ii) Adjusting institutional organization

Generally speaking, institutions are devices for achieving certain goals at a particular time and place. To this effect the institutional structure of the cotton sector symbolized by the Gezira scheme proved to be an element of success in producing cotton in commercial quantities in Sudan in the early days.

Tenants were closely supervised, loans were attached to work done and the single cotton crop provided more chances for standardizing most of the practices and operations. With diversification, the chances to do this would become less favourable.

It becomes therefore necessary to change the institutional emphasis so as to lessen reliance on administrative control and encourage economic incentive. This is tentatively suggested by results obtained for Gezira to the effect that tenants seem to respond positively to economic reward. It must be stated, however, that two things need to be stressed at this stage: any review or change in the institutional organization so as to "accommodate economic opportunities, reward and encourage growth"[1] should safeguard the national interest of growing ELS cotton and preserve the large scale of operations prevailing in the cotton sector. With the present state of cotton trade, tenants would be less inclined to give due attention to cotton if other crops are introduced. Besides the question of economic incentives and tenant's participation in management of their crops, the system of a fixed profit sharing arrangement to which ELS cotton crop is subjected needs to be reviewed. Although fixed proportionate sharing is good in bad years, it does not seem to stimulate tenants to increase their products by intensifying their effort. The need for capital accumulation and savings is quite legitimate and under any organization of production tenants are liable to pay out of their income, tax, rent, crop share... Yet emphasis should be on potential income and on creating the favourable conditions to derive that optimum level of income.[2]

(b) Issues in Price and Marketing Policy

(i) Prospects of price discrimination

In a monopolistic situation where there is some independence and choice over price formation, the producer's problem will be to maximize his returns in his product markets. Among the market outlets that are open to him, he reallocates his product in a way that maximises his return. A prior knowledge of these markets' demand elasticities becomes therefore necessary so as to guide him in doing so. By keeping these markets separate and fixing different prices for each, he achieves

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(1) Lewis, W.A., The Theory of Economic Growth, p. 142-144.

(2) Kazushi Ohkawa and Henery Rosovsky "The Role of Agriculture in Modern Japanese Economic Development", Leading Issues in Economic Development (ed.) Meier, G., 1965, p. 304-314.

his maximum return. The basic conditions for such a model to be applicable are: differences among demand price elasticities, markets indepedent of each other and total supply being controlled so as not to affect allocations of sales.(1)

Sudan, in these contexts, is not in a monopolistic position by itself so as to apply such models strictly. Yet, the oligopolistic nature of the ELS cotton market (competition among the few) and the relative importance of Sudan as being the second largest producer (25 - 30% of world production) make it appropriate to discuss such aspects of price and marketing policy.

Examining the price demand elasticities, in the selected export markets of Sudan cotton, one finds that they reflect a strong sensitivity to price changes. This is particularly so in W. Germany, Italy and India, while it is low for U.K. and France, as is given in the table below:

Table (7.1) Sudan ELS cotton price demand elasticity 1953-65

U.K.	France	W. Germany	Italy	India
insignificant	- 3.04	- 6.8	-13.5	- 5.7

Source: From table (4.13), chapter IV and equation (4.3.14) of Appendix (A).

The size of these elasticities would suggest that a price discrimination model should be adopted from the outset. However, it is not possible to entertain such an idea without taking the following factors

(1) J. Robinson, Economics of Imperfect Competition, Chapter 15, p. 181, 1933. See also Chester, O. . Fruit and Vegetable Marketing in the Economic Development of Greece, 1962, Research monograph (3) Chapter 3, p. 79-99.

into consideration:-

(1) The same demand equations for ELS of Sudan which gave the above-mentioned price elasticity, gave high cross price elasticity with the prices of other substitutes. This means that retaliation is very much to be expected especially if stocks are piled up. To the oligopolists, their joint returns will not be guaranteed to be a maximum.

(2) The income elasticity for Sudan cotton in most of these markets is very low. Besides, India's foreign exchange position may not permit a chance to exploit fully the advantages of a price discrimination in her favour.

(3) Sudan cotton supply as it is now is not controlled by one agency. It is produced on publicly controlled schemes (over 65%) and private estates (35% of ELS production). This will make concerted action difficult. Moreover Sudan's cotton supply is generally inelastic as has been empirically shown in Chapter V of this study. All cotton is produced in a fixed area and rotation.

(4) The difficulties and costs of price discrimination policy compared with the policy of uniform pricing. The extent of these factors is illustrated by Egypt's experience after 1952 where price discrimination and all other methods were attempted to alleviate the frustrated exports position. Return to free market and uniform policy was briefly outlined by the Egyptian Minister of Economy as follows:

"(i) Selling at prices in conformity with world cotton price levels,

(ii) Selling at uniform prices and on a basis of equal treatment for all world markets,

(iii) Selling on free direct basis with a view to not committing cotton exports to our imports of other commodities. In achieving this, all special bargain and bartering transactions are prohibited in order not to create various artificial prices for Egypt cotton in foreign markets.

These measures have attained the goals envisaged and influenced exports of cotton to recover many of the markets that they had lost due to the chaos that had been prevailing in marketing cotton in the past."(1)

Therefore, in order to safeguard the interests of cotton producers and the whole economy, Sudan should not go into a policy of price discrimination at a time when competition from other producers, other fibres, natural (short staples) or synthetic, is severe, together with an increasing world elasticity of demand for ELS.

Instead, more positive action is badly needed to co-ordinate ELS policies with other producers.

(ii) Co-ordination with other ELS cotton producers

Cotton is one of the primary raw materials for which no international agreement is reached to regulate production and marketing. This does not mean that cotton is operating without difficulties. On the contrary, the situation has been depressed; with declining prices, piling stocks and stagnant demand while output kept increasing.

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(1) Hassan A. Zaki, "Outlook on our Cotton Policy", 1965/66, statement referred to earlier. See also Wright, J.F., "Some reflections on the place of discrimination in the theory of monopolistic competition", 1965, O.E.P. Vol (17) July, p. 175.

The reason behind such an unhappy situation has been to a great extent the reluctance of U.S. to join any general agreement. Meanwhile she has been aggravating the situation by her cotton policy which is based on the support price that resulted in high stock figures. U.S. is the largest producer, consumer and exporter of cotton in general.

However, indirectly, U.S. policy contributed to the relative stability in the prices of short staple cotton in which she has the lead. Other producers of the same variety kept on expanding their production, accepting the prices set by U.S. for similar growths. Faced with a rapidly growing stocks figure, U.S. was forced in the end to change her support price policy (1966).(1) The new policy aims at disposing of the large stocks, decreasing output by cotton acreage curtailment and increasing U.S. share in exports by reducing export prices below previous levels.

Sudan cotton belongs to the ELS variety. This is the one mostly affected by competition with the short staple American cotton type and synthetic fibres. The determining factor among cottor varieties is the price differential paid for ELS for fineness, length and strength. It is this variation in cotton varieties that made it technically difficult to achieve an international agreement.

There has been no co-ordination among ELS cotton producers, though the possibility of establishing a harmonized policy is there due to the small number of producers. Egypt and Sudan together produce more than 70% of world production and 90% of total world exports of ELS cotton.

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(1) Kuczynski, H., "U.S. Cotton Policy of 1963", IMF staff papers, Vol. (XIII) No. (1) March, 1966, o. 52-80.

There has not even been any sort of indirect co-ordination as was the case with the short staples. To this effect one can view the U.S. policy as some sort of indirect co-ordination, with which the others will follow suit. This created some relative stability when compared with the ELS.

It is the special position of Egypt and Sudan and the absence of co-ordination that made the stability of the ELS market subject to their actions.

Actually both countries were partly responsible[1] for worsening the conditions of the ELS cotton trade during the period of study 1953-65. While Egypt has been responsible for the price policy[2] and of the fibre on the market, Sudan increased her output by doubling the area under cotton. This together with the stagnant state of demand resulted in declining price, stockpiling and sharp fluctuations in foreign exchange earnings.

Both Egypt and Sudan rely heavily on cotton exports. ELS cotton is a crop subject to wide output fluctuations due to its vulnerability to weather conditions, diseases and pest attacks. The adverse effect of these random factors is accentuated by the absence of consciously concerted marketing policy.

The lack of such co-ordination manifested itself on two occasions during the period of study. In 1967/58 when Egypt reduced her cotton prices Sudan refrained from following suit.

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(1) This is contrary to what is sometimes maintained, that Sudan is a small producer and it can not significantly influence the market. This is a simplification based on Sudan's share in the market of cotton of all types. See A.A. Suliman, "Cotton Stabilization Policy in Sudan", African Primary Products (ed.) Stewart, I., 1965, p. 164.

(2) Egypt's ELS cotton price showed the highest degree of variation of all fibre prices considered (Table (4.5) Chapter IV. For a discussion of Egypt's cotton policies, see Hansen, B. and Marzouk G., Development and Economic Policy in the U.A.R. (Egypt), 1965, p. 95-109 and p. 200-201.

Sudan kept the reserve price at the levels she deemed reasonable from her point of view. And by not responding to Egypt's action, Sudan cotton was held off the market until it was forced to sell at an even lower price than before; by which time the market was already satisfied from Egyptian growth. The second incident, though less serious, took place in 1965/66 when Sudan did not reduce her cotton prices as Egypt did.

The two above mentioned incidents besides reflecting lack of co-ordination, refer to the possibility of Sudan diverging from Egypt when pricing her cotton. This is a finding referred to earlier when in the multiple regression equation explaining the variation in Sudan prices, the whole effect was accounted for by the Peruvian price (P_p) and not the Egyptian (P_e).

For Sudan to do this, stick to her reserve price in the auctions, refrain from any reductions, sacrificing immediate sales and adding to her stocks, can only be feasible under the following conditions:

(1) Foreseeing a situation in future when she can sell at prices higher than those at present plus the expenses incurred in keeping stocks.

(2) Affording to maintain the high price and tying up much of the working capital.

(3) If buyers cannot obtain their supplies from other sources.

Yet the fact remains, that Sudan has not got the lead in the oligopolistic market of ELS cotton, or the resources to cope with the adverse grave consequences of not responding to a market situation and matching competition.

It is therefore to the benefit of the producers and consumers of ELS cotton that a co-ordinated policy be operated between Egypt and Sudan. This does not, however, exclude the possibility of including other producers. Yet an initiative from Egypt and Sudan will ensure that the largest part of ELS cotton trade is co-ordinated. Such positive action is a question that needs more concern at present. At least it will create favourable conditions to match the concerted policy of U.S. for short staple cotton and the big affiliated companies producing synthetic and industrial fibres.

(iii) Co-ordination of Internal ELS Cotton Marketing

The marketing institutions handling the ELS cotton crop has been reviewed in Chapter III. From that review it was very obvious that some sort of dualism exists in dealing with a single crop, cotton. If this is the case, it seems unreasonable to aim at co-ordination with other countries producing a similar variety before putting the internal marketing into order. At present only public sector cotton is sold at the auction while the privately produced cotton is sold outside the auction between producers and exporters at prices less than those obtained for public auctioned cotton. Schemes which take loans from the Agriculture bank affect their sales under its supervision.

The dualism in the marketing arrangement of Sudan cotton might be an historic phenomenon which has to be subjected to new thinking according to the rise of the present circumstances of the economy. The historic nature is explained by the existence of the vast Gezira Scheme which deals with production and marketing of public cotton, while the newly established private schemes departed from Gezira organisation in the marketing of the crop. They do not have the size and the facilities available to Gezira and there is no reason for not co-ordinating at the most important phase of cotton business, i.e. marketing.

The cotton sector can thus be viewed as one unit towards which a concerted policy can be framed. The present dualism can be removed by entrusting all the marketing operations to one body. More important is that the agricultural bank will be wholly engaged in credit and finance operations without being involved in marketing as at present.

Separation of marketing and finance as envisaged before is some sort of specialization which would create more favourable conditions for efficiency and proper co-ordination between available means and desirable goals.

The form(1) in which co-ordination should take place can only be decided upon after considering the experiences of other primary producers as well as the local conditions of Sudan.

However, the presence of the Gezira organization with all the equipment and experience accumulated would immediately suggest setting up a marketing board for all Sudan cotton. At present Gezira is empowered to regulate production and conduct marketing for more than 60% of Sudan cotton. The size of the organization and the available facilities will ensure the advantages of scale if the scope of operations is widened to include the privately produced cotton.

Re-organizing the present marketing machinery of public cotton (Gezira) will improve the efficiency and reduce the marketing expenses incurred. It will increase the bargaining power of the whole cotton industry and improve the marketing organization by regulating and harmonizing the market procedures, sale practices and scale of operations. (1962/63

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(1) Abbot, G., Marketing Boards: Their Establishment and Operation, . 1966, F.A.O., Rome.

marketing expenses were 0.42% and 1% of crop value for Gezira and private[1] cotton estates respectively.)

(iv) Need for Cotton Stabilization Policy

Though Sudan suffers relatively more than some other primary producers from export fluctuations, no stabilization policy was introduced. The factors responsible for these fluctuations are both demand and supply factors. This has been revealed by the empirical analysis of both supply and demand for ELS of Sudan in the earlier parts of this study.

On the supply side ELS cotton is subject to wide variations due to weather conditions and insect attack. Besides, cotton production is concentrated in the special variety of ELS with no other export cash crop to share the risks of fluctuations. The institutional aspect of the cotton industry in the Sudan adds to the inelasticity and rigidity of supply as cotton is grown in schemes with fixed area and rotation. All these factors resulted in sharp fluctuations, adversely affecting producers' income and the stability of the whole economy.

On the demand side, ELS in general suffered from stagnant demand and declining prices. More specifically for Sudan, is the loss of her major traditional export market, U.K. This happened at a time when Sudan almost doubled the area under ELS cotton and has to repay the loans invested in these extensions.

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(2) Charges made by the Agriculture bank on private estates borrowing from it are as follows: 6% interest, 2% of total value of cotton to cover management expenses and 1% commission for selling the crop.

Though the argument may not be conclusive as to whether supply or demand is responsible for the depressed situation of ELS, the available evidence points to demand being responsible in Sudan's case.

The price elasticity of demand for Sudan ELS turned out to be very high in four out of the five export markets studied. This high sensitivity of demand to price and the loss of the British traditional market refer to demand deficiency thesis as being the cause. Such conviction is further reinforced by the fact that the piling of stocks increased the elasticity of supply of Sudan ELS cotton. This would have matched any steady or growing demand.

Despite its key position as the backbone of the Sudanese economy, no stabilization policy, on the lines of those adopted by other primary producers, was made for Sudan cotton. However, all that exists is a reserve fund for Gezira tenants and a reserve equalization fund to cope with government revenue fluctuations.

(v) Increase in Productivity and Improving Quality of Cotton Grades

The need to improve the grades of Sudan cotton has been referred to earlier. Better grades of ELS command higher price. Grade is a composite measure of length, strength, cleanliness, colour and spinning performance.

Apart from agronomic research, no other measures are taken to improve these grades. Much of the quality improvement required depends upon the tenant's effort and attention. To this effect the price policy can be geared with price differentials for each grade.

The present accounting practice in cotton schemes is another implication of the institutional set up of these schemes, symbolised by Gezira. Cotton is received from each tenant against a receipt indicating the volume. Then the processes of ginning, grading and marketing takes place. When the proceeds are realized each tenant is paid according to his output indiscriminately. The difference of earnings is a quantity rather than a quality one. The same rule applies to cotton expenses incurred during a crop year. They are charged to each tenancy indiscriminately as well. The effect of this is accentuated with the sharp variations of the crop and the vast size of Gezira scheme.

To sum up, it is most likely that ELS cotton will remain the backbone of the Sudanese economy, at least in the foreseeable future. Although the short run prospects of ELS cotton do not seem to be very bleak, yet in the long-term these prospects may not be very bright. The heavy investment and research in progress in the man-made fibres industry will continue to be a threat to natural fibres. A breakthrough in improving the technical qualities of these synthetic fibres (e.g. moisture absorbency), will adversely affect ELS cotton, the quality fibre favoured in production of fine textiles. The concentration of the man-made fibres industry in the developed high income countries means that most of the loss would be experienced in these markets first. On the other hand, the potential demand for cotton textiles in general and fine cloth in particular, existing in the markets of the developing countries, could only be considered as an effective demand with rising incomes and standards of living subsequent to and depending on the speed of the process of economic development in these regions.

Therefore, efforts in Sudan must be directed towards reducing her sole reliance on this single commodity, by a more general diversification of the economy and strengthening its inter-sectoral relationships. The Sudanese agricultural sector should adopt a more stable pattern of production that would accommodate changes in demand and provide better utilization of the country's basic factor endowment. Agricultural research should be stepped up and encouraged to explore these other possibilities besides cotton in the different regions of the country. Special attention should be given to the livestock resource which at present contributes about 10% of Gross Domestic Product while still highly inoptimally exploited.

On the other hand industrial development based on processing the raw materials locally produced should be encouraged wherever and whenever it is economically and technically feasible. As the size of the domestic market is small, most of the established industries would be export biased. To compete in the export markets, this, undoubtedly, means that Sudan should preserve the same comparative advantage she already enjoys in the locally produced raw materials.

APPENDEX A

Table (1)

DEMAND FUNCTIONS FOR RAW COTTON (all types)
U.K., France, Germany F.R., Italy and India
1953 - 1965

Appendix (A)

Eq. No.		$\bar{R}^2$	$\frac{\delta^2}{S^2}$
	I U.K.		
(4.1.1)	$\log q = 6.7582 - \underset{(0.2707)}{0.0064} \log Pa_{(t-1)} + \underset{(0.6741)}{0.9457} \log Pr - \underset{(0.4135)}{2.2369} \log Y$	0.91	2.316
(4.1.2)	$\log q = 2.3386 - \underset{(0.2615)}{0.0923} \log Pa_{(t-1)} + \underset{(0.6341)}{0.9582} \log Pr - \underset{(1.3895)}{0.3297} \log Y - \underset{(0.6337)}{0.6482}t$	0.92	2.315
(4.1.3)	$\log q = 1.5543 - \underset{(0.2455)}{0.0939} \log Pa_{(t-1)} + \underset{(0.5952)}{0.9633} \log Pr - \underset{(0.0089)}{0.0559}t$	0.93	2.339
(4.1.4)	$\log q = 0.3234 + \underset{(0.4121)}{1.0279} \log Pa_{(t-1)} + \underset{(1.8171)}{1.4108} \log Pr - \underset{(1.1991)}{0.2168} \log X$	0.56	1.552
(4.1.5)	$\log q = -0.7029 - \underset{(0.1858)}{0.1945} \log Pa_{(t-1)} - \underset{(0.5767)}{0.0554} \log Pr + \underset{(0.3926)}{1.0779} \log X - \underset{(0.0071)}{0.0613}t$	0.96	2.578
	II France		
(4.1.6)	$\log q = 4.2877 - \underset{(0.1424)}{0.4173} \log Pa_{(t-1)} - \underset{(0.1976)}{0.4382} \log Pr - \underset{(0.1171)}{0.6160} \log Y - \underset{(0.0719)}{0.1397} \log S_{(t-1)}$	0.75	2.452
(4.1.7)	$\log q = 3.9541 - \underset{(0.1638)}{0.4536} \log Pa_{(t-1)} - \underset{(0.2253)}{0.5101} \log Pr - \underset{(0.1357)}{0.6048} \log Y$	0.67	2.922
(4.1.8)	$\log q = 3.4333 - \underset{(0.1831)}{0.5006} \log Pa_{(t-1)} - \underset{(2407)}{0.4697} \log Pr - \underset{(0.2953)}{0.4282} \log Y - \underset{(0.0156)}{0.0102}t$	0.64	2.822

Table (1) cont/d..

	II France		
(4.1.9)	$\log q = 1.7073 - \underset{(0.2078)}{0.4895} \log Pa_{(t-1)} - \underset{(0.2684)}{0.3955} \log Pr + \underset{(0.3776)}{0.1375} \log X - \underset{(0.0107)}{0.0319t}$	0.55	2.593
	III Germany F.R.		
(4.1.10)	$\log q = 3.7849 - \underset{(0.3385)}{0.5758} \log Pa_{(t-1)} + \underset{(0.6497)}{0.3762} \log Pr - \underset{(0.2497)}{0.5232} \log Y$	0.32	1.232
(4.1.11)	$\log q = 1.0457 - \underset{(0.1421)}{0.5266} \log Pa_{(t-1)} + \underset{(0.2737)}{0.1947} \log Pr + \underset{(0.2543)}{0.9162} \log Y - \underset{(0.0131)}{0.0812t}$	0.88	2.687
(4.1.12)	$\log q = 2.1594 - \underset{(0.2172)}{0.6566} \log Pa_{(t-1)} + \underset{(0.4322)}{0.1458} \log Pr - \underset{(0.0085)}{0.0383t}$	0.70	1.768
(4.1.13)	$\log q = 2.0684 - \underset{(0.1645)}{0.6124} \log Pa_{(t-1)} - \underset{(0.0075)}{0.0393t}$	0.73	1.777
(4.1.14)	$\log q = 1.0685 - \underset{(0.2472)}{0.5413} \log Pa_{(t-1)} - \underset{(0.6027)}{0.2662} \log Pr + \underset{(0.4404)}{0.4329} \log X - \underset{(0.0190)}{0.0550t}$	0.70	1.735
	IV Italy		
(4.1.15)	$\log q = 0.4006 + \underset{(0.5015)}{0.4964} \log Pa_{(t-1)} - \underset{(0.5491)}{0.8854} \log Pr + \underset{(0.2409)}{0.3229} \log Y$	0.38	2.063
(4.1.16)	$\log q = 1.5174 - \underset{(0.1637)}{0.3859} \log Pa_{(t-1)}$	0.29	1.467
(4.1.17)	$\log q = -0.7372 + \underset{(0.3136)}{0.4340} \log Pa_{(t-1)} - \underset{(0.4253)}{0.8266} \log Pr + \underset{(0.2221)}{0.5984} \log X$	0.60	2.723
(4.1.18)	$\log q = -0.8511 + \underset{(0.3289)}{0.4667} \log Pa_{(t-1)} - \underset{(0.4521)}{0.8929} \log Pr + \underset{(0.2489)}{0.5357} \log X + \underset{(0.1238)}{0.0822} \log S_{(t-1)}$	0.57	2.847

Table (1) cont/d..

V <u>India</u> (1953-1964)

(4.1.19)	$\log q = -1.2691 - \underset{(0.0175)}{0.0742} \log Pa_{(t-1)} + \underset{(0.1485)}{0.5300} \log Y + \underset{(0.0305)}{0.2477} \log S_{(t-1)}$	0.88	1.532
(4.1.20)	$\log q = -1.2201 - \underset{(0.0377)}{0.0612} \log Pa_{(t-1)} + \underset{(0.0243)}{0.0096} \log q_r + \underset{(0.1621)}{0.5162} \log Y + \underset{(0.0389)}{0.2392} \log S_{(t-1)}$	0.86	1.643
(4.1.21)	$\log q = -1.8487 + \underset{(0.0480)}{0.1650} \log Pa_{(t-1)} - \underset{(0.6617)}{0.1236} \log q_r + \underset{(0.2786)}{1.1069} \log X$	0.72	2.043
(4.1.22)	$\log q = -1.2911 + \underset{(0.0562)}{0.0768} \log Pa_{(t-1)} \underset{(0.0527)}{-0.0869} \log q_r + \underset{(0.2871)}{0.7199} \log X + \underset{(0.0544)}{0.1182} \log S_{(t-1)}$	0.82	2.099

<u>Price of Indian Jarilla fine (P_j) instead of American price (Pa)</u>

(4.1.23)	$\log q = -0.9574 - \underset{(0.0535)}{0.0411} \log Pj_{(t-1)} + \underset{(0.0140)}{0.0418} \log q_r + \underset{(0.1747)}{0.4311} \log Y + \underset{(0.0415)}{0.2181} \log S_{(t-1)}$	0.82	2.065
(4.1.24)	$\log q = -0.7717 - \underset{(0.0606)}{0.0269} \log Pj_{(t-1)} - \underset{(0.0572)}{0.0668} \log q_r + \underset{(0.2348)}{0.4396} \log X + \underset{(0.0479)}{0.1819} \log S_{(t-1)}$	0.77	2.000

Table (2) **WORLD DEMAND FOR EXTRA-LONG STAPLE COTTON (ELS)** Appendix (A)

1953-1965

Eq. No.	I World	$\bar{R}^2$	$\frac{\delta^2}{S^2}$
(4.2.1)	$\log Q = 3.6014 - \underset{(0.2218)}{0.8373} \log P_{ELS_{(t-1)}} + \underset{(0.1853)}{0.4572} \log X_{W2}$	0.78	2.134
(4.2.2)	$\log Q = 5.0211 - \underset{(0.2324)}{1.1232} \log P_{ELS_{(t-1)}}$	0.67	1.691
(4.2.3)	$\log Q = 3.2662 - \underset{(0.4713)}{0.5749} \log \left(\frac{P_{ELS}}{P_a}\right)_{t-1}$	0.04	0.484
(4.2.4)	$\log Q = 2.5497 - \underset{(0.2180)}{0.9200} \log P_{ELS_{(t-1)}} + \underset{(0.2853)}{0.6238} \log Q_r$	0.76	2.121
(4.2.5)	$\log Q = 3.0158 - \underset{(0.2274)}{0.8022} \log P_{ELS_{(t-1)}} + \underset{(0.2875)}{0.7206} \log X_{W_1}$	0.78	2.228
(4.2.6)	$\log Q = 5.3661 - \underset{(0.2677)}{0.7499} \log P_{ELS_{(t-1)}} - \underset{(1.4783)}{0.9381} \log Q_r + \underset{(1.0088)}{1.0857} \log X_{W_2}$	0.76	2.211
(4.2.7)	$\log Q = 3.8115 - \underset{(0.2943)}{0.6998} \log P_{ELS_{(t-1)}} - \underset{(1.2761)}{0.7445} \log Q_r + \underset{(1.3599)}{1.4946} \log X_{W_1}$		

Table (2) cont/d..

(4.2.8)	$\log Q = 5.7358 - \underset{(0.3116)}{0.4986} \log \left(\frac{P_{ELS}}{P_a}\right)_{t-1} - \underset{(1.6922)}{1.9915} \log Q_r + \underset{(1.0787)}{2.0959} \log X_{W_2}$	0.648	1.566
(4.2.9)	$\log Q = 3.1923 - \underset{(0.2821)}{0.4771} \log \left(\frac{P_{ELS}}{P_a}\right)_{t-1} - \underset{(1.2427)}{1.7530} \log Q_r + \underset{(1.1979)}{2.9645} \log X_{W_1}$	0.707	1.963
(4.2.10)	$\log Q = 4.3959 - \underset{(0.2256)}{0.7939} \log P_{ELS(t-1)} + \underset{(0.0123}{0.0316}\, t$	0.789	2.2358

II World Excluding East Europe (for definitions see text, page 41)

(4.2.11)	$\log Q^1 = 2.0245 - \underset{(0.2502)}{1.0968} \log \left(\frac{P_{ELS}}{P_a}\right)_{t-1} + \underset{(0.2131)}{0.5629} \log X_{W_{22}}$	0.67	3.192
(4.2.12)	$\log Q^1 = 4.4502 - \underset{(0.2577)}{0.8942} \log P_{ELS(t-1)}$	0.50	2.532
(4.2.13)	$\log Q^1 = 3.1734 - \underset{(0.3151)}{1.0397} \log \left(\frac{P_{ELS}}{P_a}\right)_{t-1}$	0.47	1.854
(4.2.14)	$\log Q^1 = 0.7825 - \underset{(0.2572)}{1.1276} \log \left(\frac{P_{ELS}}{P_a}\right)_{t-1} + \underset{(0.2809)}{0.7047} \log Q_r$	0.65	3.059
(4.2.15)	$\log Q^1 = 1.6323 - \underset{(0.2873)}{1.0947} \log \left(\frac{P_{ELS}}{P_a}\right)_{t-1} - \underset{(2.2223)}{0.0502} \log Q_r + \underset{(2.4603)}{0.8432} \log X_{W_{11}}$	0.62	3.206
(4.2.16)	$\log Q^1 = 3.3469 - \underset{(0.2794)}{1.0681} \log \left(\frac{P_{ELS}}{P_a}\right)_{t-1} - \underset{(1.9652)}{0.6141} \log Q_r + \underset{(1.5239)}{1.0340} \log X_{W_{22}}$	0.63	3.254

Table (2) cont/d..

(4.2.17)	$\log Q^{1} = \underset{}{1.5737} - \underset{(0.2539)}{1.0969} \log \left(\frac{P_{ELS}}{P_a}\right)_{t-1} + \underset{(0.3088)}{0.7882} \log X_{W_{11}}$	0.66	3.199
(4.2.18)	$\log Q' = 3.1035 - \underset{(0.2447)}{1.0576} \log \left(\frac{P_{ELS}}{P_a}\right)_{t-1} + \underset{(0.0112)}{0.0308}\, t$	0.68	3.3065

Table (3) — Appendix (A)

DEMAND FUNCTION OF SUDAN ELS COTTON IN FOREIGN EXPORT MARKETS OF U.K., FRANCE, W. GERMANY, ITALY AND INDIA

1953 - 1965

I. U.K.

Eq. No.	Equation	$\bar{R}^2$	$\frac{\delta^2}{S^2}$
(4.3.1)	$\log q = 11.8017 - \underset{(0.5689)}{0.6847} \log P_s - \underset{(0.7689)}{4.3215} \log Y$	0.73	2.250
(4.3.2)	$\log q = 11.6129 - \underset{(0.6019)}{0.6740} \log P_s - \underset{(0.7161)}{0.1225} \log P_d - \underset{(0.8108)}{4.3301} \log Y$	0.71	2.236
(4.3.3)	$\log q = 19.5867 - \underset{(0.9691)}{0.2883} \log P_s + \underset{(0.9948)}{0.1821} \log P_a + \underset{(3.2131)}{10.8948} \log P_r - \underset{(3.3360)}{8.2944} \log X$	0.44	1.408
(4.3.4.)	$\log q = 12.1978 - \underset{(0.7111)}{0.4377} \log P_s + \underset{(0.7884)}{0.1189} \log P_a - \underset{(2.5691)}{2.2609} \log P_r - \underset{(6.2880)}{4.9408} \log Y - \underset{(0.1475)}{0.0046}\, t$	0.66	2.721
(4.3.5)	$\log q = 12.8893 + \underset{(0.4179)}{0.2065} \log P_s + \underset{(0.4218)}{0.3422} \log P_a + \underset{(1.8349)}{3.3333} \log P_r - \underset{(1.4504)}{6.2551} \log X - \underset{(0.0166}{0.1018}\, t$	0.90	3.700
(4.3.6)	$\log q = 12.4304 - \underset{(2.2244)}{2.5974} \log P_s - \underset{(0.5587)}{0.2073} \log \left(\frac{P_s}{P_a}\right) + \underset{(2.3745)}{2.3756} \log \left(\frac{P_s}{P_r}\right) - \underset{(1.1649)}{5.1151} \log Y$	0.71	2.671

Table (3) cont/d..

(4.3.7)	$\log q = 19.2719 + \underset{(3.5649)}{10.7248} \log P_s - \underset{(0.7228)}{0.3398} \log \left(\frac{P_s}{P_a}\right) - \underset{(3.2164)}{10.6417} \log \left(\frac{P_s}{P_r}\right) - \underset{(3.3296)}{8.3166} \log X$	0.44	1.369
(4.3.8)	$\log q = 12.7611 + \underset{(1.8545)}{3.6375} \log P_s - \underset{(0.3197)}{0.3411} \log \left(\frac{P_s}{P_a}\right) - \underset{(1.7904)}{3.0900} \log \left(\frac{P_s}{P_r}\right) - \underset{(1.4171)}{6.2197} \log X$ $- \underset{(0.0161)}{0.1013}\, t$	0.90	3.617

II. <u>France (In all the equations cotton prices (P_s), (P_e) and (P_a) or their transformations are non-deflated absolute prices)</u>

(4.3.9)	$\log q = 5.0274 + \underset{(0.3971)}{0.1500} \log P_s - \underset{(0.9053)}{4.3623} \log P_a + \underset{(0.8058)}{4.2501} \log P_r$	0.71	2.769
(4.3.10)	$\log q = 5.8658 + \underset{(1.1589)}{0.6627} \log P_s - \underset{(1.1776)}{0.6291} \log P_e - \underset{(1.0935)}{4.0946} \log P_a + \underset{(1.3638)}{3.7173} \log P_r$ $- \underset{(0.8442)}{0.2813} \log Y$	0.64	2.653
(4.3.11)	$\log q = 4.7012 + \underset{(1.3824)}{0.8551} \log P_s - \underset{(1.2339)}{0.7147} \log P_e - \underset{(1.1101)}{4.1316} \log P_a + \underset{(1.9202)}{4.2820} \log P_r$ $+ \underset{(0.0662)}{0.0097}\, t$	0.64	2.828
(4.3.12)	$\log q = 1.1017 + \underset{(1.5553)}{0.9686} \log \left(\frac{P_s}{P_e}\right) + \underset{(1.0155)}{1.5487} \log \left(\frac{P_s}{P_a}\right) - \underset{(0.6006)}{1.3317} \log \left(\frac{P_s}{P_r}\right)$	0.37	2.654
(4.3.13)	$\log q = 7.7812 - \underset{(1.2940)}{1.8684} \log P_s + \underset{(1.5395)}{0.8022} \log \left(\frac{P_s}{P_e}\right) + \underset{(1.1726)}{2.4857} \log \left(\frac{P_s}{P_a}\right) - \underset{(0.7201)}{0.7316} \log \left(\frac{P_s}{P_r}\right)$ $- \underset{(0.9075)}{1.3712} \log Y$	0.39	2.570

Table (3) cont/d..

(4.3.14)	$\log q = 11.1950 - \underset{(0.9929)}{3.0393} \log P_s + \underset{(1.0591)}{2.5933} \log \left(\frac{P_s}{P_a}\right) - \underset{(0.7401)}{2.1437} \log Y$	0.38	1.702
(4.3.15)	$\log q = 5.3922 - \underset{(0.5068)}{0.8347} \log P_s - \underset{(0.9684)}{2.9868} \log P_a - \underset{(0.0343)}{0.1246}\, t$	0.51	2.240
III Germany, F.R.			
(4.3.16)	$\log q = 10.4978 - \underset{(1.9961)}{6.8534} \log P_s + \underset{(1.6181)}{4.2279} \log P_e - \underset{(1.6111)}{4.7182} \log P_a + \underset{(3.8914)}{10.1156} \log P_r + \underset{(1.2912)}{0.6251} \log Y$	0.80	2.714
(4.3.17)	$\log q = 11.3451 - \underset{(1.9472)}{7.0941} \log P_s + \underset{(1.5345)}{4.3841} \log P_e - \underset{(1.5166)}{4.8114} \log P_a + \underset{(3.7403)}{9.9217} \log P_r + \underset{(1.1700)}{0.7455} \log X$	0.805	2.691
(4.3.18)	$\log q = 7.0775 - \underset{(2.1208)}{6.7874} \log P_s + \underset{(1.7241)}{4.1458} \log P_e - \underset{(1.7379)}{4.5652} \log P_a + \underset{(4.1396)}{9.9535} \log P_r + \underset{(2.3471)}{1.6072} \log Y - \underset{(0.1154)}{0.0551}\, t$	0.78	2.611
(4.3.19)	$\log q = 9.6097 - \underset{(2.1478)}{7.3872} \log P_s + \underset{(1.6663)}{4.5636} \log P_e - \underset{(1.6094)}{4.8581} \log P_a + \underset{(4.1103)}{9.3859} \log P_r + \underset{(2.3808)}{1.7401} \log X - \underset{(0.1059)}{0.0518}\, t$	0.78	2.558
(4.3.20)	$\log q = 12.8344 - \underset{(2.0146)}{7.0108} \log P_s + \underset{(1.6025)}{4.4473} \log P_e - \underset{(1.5384)}{5.0294} \log P_a + \underset{(3.9562)}{9.6471} \log P_r + \underset{(0.0533)}{0.0143}\, t$	0.80	2.718
(4.3.21)	$\log q = -5.6466 - \underset{(0.6842)}{1.0889} \log P_s - \underset{(1.0896)}{1.1385} \log q_r + \underset{(0.9655)}{2.2815} \log Y$	0.67	2.202

Table (3) cont/d..

IV. <u>Italy</u>

(4.3.22)	$\log q = 1.6333 - \underset{(2,6327)}{13.5376} \log P_s + \underset{(2.5716)}{12.0260} \log P_e$	0.67	3.128
(4.3.23)	$\log q = 9.5848 - \underset{(3.6674)}{14.0568} \log P_s + \underset{(3.5617)}{12.1826} \log P_e - \underset{(3.3761)}{3.4752} \log P_a + \underset{(4.1943)}{2.8132} \log P_r - \underset{(2.1720)}{1.1613} \log Y$	0.60	2.591
(4.3.24)	$\log q = 1.9655 - \underset{(3.1901)}{12.5769} \log P_s + \underset{(3.3120)}{11.2307} \log P_e - \underset{(2.4659)}{1.8867} \log P_a + \underset{(4.2372)}{2.7591} \log P_r + \underset{(2.1631)}{0.7830} \log X$	0.59	2.817
(4.3.25)	$\log q = 4.1375 - \underset{(2.5013)}{10.6817} \log \left(\frac{P_s}{P_e}\right) + \underset{(1.3882)}{2.3805} \log \left(\frac{P_s}{P_a}\right) - \underset{(1.3924)}{3.7852} \log \left(\frac{P_s}{P_r}\right)$	0.74	2.004
(4.3.26)	$\log q = 0.2173 - \underset{(3.0132)}{13.1109} \log P_s + \underset{(2.7162)}{11.9003} \log P_e + \underset{(1.0574)}{0.3707} \log Y$	0.64	3.035
(4.3.27)	$\log q = -3.9550 - \underset{(2.6779)}{12.0815} \log \left(\frac{P_s}{P_e}\right) + \underset{(0.7329)}{1.2374} \log Y$	0.66	2.704
(4.3.28)	$\log q = -26.0651 - \underset{(4.1101)}{18.1443} \log P_s + \underset{(4.1146)}{16.4817} \log P_e - \underset{(3.1058)}{4.6559} \log P_a + \underset{(3.7562)}{2.9628} \log P_r + \underset{(9.7676)}{14.6636} \log Y - \underset{(0.5918)}{0.9783}\, t$	0.68	3.081

Table (3) cont/d..

(4.3.29) $$\log q = 2.9447 - \underset{(3.7401)}{16.7357} \log P_s + \underset{(3.6421)}{14.8908} \log P_e - \underset{(3.3781)}{6.2647} \log P_a + \underset{(3.7708)}{3.4439} \log P_r + \underset{(2.7166)}{4.0533} \log X - \underset{(0.1670)}{0.2841}\, t$$ 0.68 3.134

(4.3.30) $$\log q = -5.6879 - \underset{(2.5920)}{12.3239} \log \left(\frac{P_s}{P_a}\right) + \underset{(1.2455)}{2.3567} \log X$$ 0.68 3.086

V. <u>India 1953-1964, (Income cariable (Y) is aggregate and not per capita in all India's demand equations)</u>

(4.3.31) $$\log Q = 20.5358 - \underset{(1.4982)}{5.7294} \log P_s + \underset{(1.1855)}{3.4909} \log P_e - \underset{(0.9616)}{1.9775} \log P_a + \underset{(1.4997)}{3.1439} \log Q_r - \underset{(2.8727)}{7.7903} \log Y - \underset{(0.25360)}{0.44885}\, t$$ 0.71 2.252

(4.3.32) $$\log Q = 17.8729 - \underset{(1.3250)}{4.0052} \log P_s + \underset{(1.3755)}{3.3204} \log P_e - \underset{(1.0081)}{1.2373} \log P_a + \underset{(0.5040)}{0.6029} \log Q_r - \underset{(3.2911)}{6.8865} \log Y$$ 0.61 1.9782

(4.3.33) $$\log Q = 14.4429 - \underset{(1.4470)}{3.6403} \log P_s + \underset{(1.3915)}{2.7208} \log P_e - \underset{(1.2158)}{0.6234} \log P_j + \underset{(0.6441)}{0.9303} \log Q_r - \underset{(3.4695)}{5.7343} \log Y$$ 0.53 1.665

(4.3.34) $$\log Q = 4.1617 - \underset{(1.6637)}{3.7332} \log P_s + \underset{(1.6160)}{2.7626} \log P_e - \underset{(1.1572)}{0.5070} \log P_a - \underset{(0.0811)}{0.0342}\, t$$ 0.43 2.209

(4.3.35) $$\log Q = 3.3618 - \underset{(1.6631)}{3.6025} \log P_s + \underset{(1.5449)}{2.5126} \log P_e + \underset{(1.1992)}{0.1793} \log P_j - \underset{(0.0522)}{0.0085}\, t$$ 0.41 1.994

(4.3.36) $$\text{Log } Q = -0.3795 - \underset{(1.7264)}{3.6617} \log P_s + \underset{(1.7576)}{2.7604} \log P_e - \underset{(1.3212)}{0.0499} \log P_a - \underset{(1.0427)}{0.4539} \log Q_r + \underset{(5.6493)}{2.1934} \log X$$ 0.33 2.115

Table (3) cont/d..

(4.3.37)	$\log Q = 3.3824 - \underset{(1.4882)}{3.4981} \log P_s + \underset{(1.4469)}{2.5209} \log P_e - \underset{(0.2614)}{0.0003} \log Q_r$	0.48	2.039
(4.3.38)	$\log Q = 5.9689 - \underset{(1.4501)}{3.7734} \log P_s + \underset{(1.4036)}{2.5982} \log P_e - \underset{(1.5188)}{1.1029} \log Y$	0.51	1.814
(4.3.39)	$\log Q = 3.3814 - \underset{(1.3622)}{3.4976} \log P_s + \underset{(1.3623)}{2.5208} \log P_e$	0.54	2.039

(Table 4) Appendix A

ELASTICITY OF SUBSTITUTION (Relative quantity - price method) of Sudan ELS Cotton with Egyptian ELS and American short staples in U.K., France, W. Germany, Italy and India

1953 - 1965

(a) Sudan ELS/Egypt ELS Cotton

Eq. No.	Equation	$\bar{R}$	$\frac{\delta^2}{S^2}$
	I France		
(4.4.1)	$\log\left(\frac{qs}{qe}\right) = -0.4564 + \underset{(2.4408)}{6.2598} \log\left(\frac{Ps}{Pe}\right) + \underset{(0.0436)}{0.0828}t$	0.59	2.160
(4.4.2)	$\log\left(\frac{qs}{qe}\right) = -0.2797 + \underset{(2.7249)}{5.1190} \log\left(\frac{Ps}{Pe}\right)$	0.42	1.480
(4.4.3)	$\log\left(\frac{qe}{qs}\right) = -5.5574 + \underset{(2.5996)}{5.7732} \log\left(\frac{Ps}{Pe}\right) + \underset{(0.9965)}{1.5456} \log Y$	0.52	2.029
	II Germany, F.R.		
(4.4.4)	$\log\left(\frac{qs}{qe}\right) = -48.6391 + \underset{(1.7205)}{3.6365} \log\left(\frac{Ps}{Pe}\right) + \underset{(4.7499)}{14.9099} \log Y - \underset{(0.2736)}{0.7319}t$	0.75	1.652
(4.4.5)	$\log\left(\frac{qs}{qe}\right) = 0.1110 + \underset{(2.4907)}{2.4525} \log\left(\frac{Ps}{Pe}\right)$	0.05	1.118
(4.4.6)	$\log\left(\frac{qs}{qe}\right) = -7.9777 + \underset{(2.0861)}{2.2548} \log\left(\frac{Ps}{Pe}\right) + \underset{(0.9946)}{2.3759} \log Y$	0.59	1.584
(4.4.7)	$\log\left(\frac{qs}{qe}\right) = -0.2053 + \underset{(2.2609)}{2.0712} \log\left(\frac{Ps}{Pe}\right) + \underset{(0.0619)}{0.1511}t$	0.42	1.507
	III Italy		
(4.4.8)	$\log\left(\frac{qs}{qe}\right) = -5.3233 - \underset{(2.9598)}{7.5202} \log\left(\frac{Ps}{Pe}\right) + \underset{(0.8101)}{1.9763} \log Y$	0.71	1.987

Table (4) cont/d..

III *Italy*

$$(4.4.9)\quad \log\left(\frac{qs}{qe}\right) = -0.4306 - \underset{(3.5411)}{9.3427} \log\left(\frac{Ps}{Pe}\right) \qquad 0.52 \quad 1.206$$

$$(4.4.10)\quad \log\left(\frac{qs}{qe}\right) = -0.6879 - \underset{(3.0310)}{7.1190} \log\left(\frac{Ps}{Pe}\right) + \underset{(0.0488)}{0.1142t} \qquad 0.70 \quad 1.953$$

IV *India* (1953-64)

$$(4.4.11)\quad \log\left(\frac{Qs}{Qe}\right) = -0.2235 + \underset{(2.4616)}{1.2609} \log\left(\frac{Ps}{Pe}\right) + \underset{(0.0472)}{0.0793t} \qquad 0.28 \quad 1.471$$

$$(4.4.12)\quad \log\left(\frac{Qs}{Qe}\right) = -0.0482 + \underset{(2.6582)}{0.7740} \log\left(\frac{Ps}{Pe}\right) \qquad 0.30 \quad 1.107$$

$$(4.4.13)\quad \log\left(\frac{Qs}{Qe}\right) = -5.1555 + \underset{(2.5968)}{0.7709} \log\left(\frac{Ps}{Pe}\right) + \underset{(1.6929)}{2.0587} \log Y \qquad 0.20 \quad 1.392$$

(b) *Sudan ELS/American Cotton*

I *U.K.*

$$(4.4.14)\quad \log\left(\frac{qs}{qa}\right) = -0.0607 - \underset{(0.8626)}{1.6928} \log\left(\frac{Ps}{Pa}\right) \qquad 0.44 \quad 3.122$$

$$(4.4.15)\quad \log\left(\frac{qs}{qa}\right) = -0.9276 - \underset{(0.9228)}{1.7291} \log\left(\frac{Ps}{Pa}\right) + \underset{(1.8753)}{0.3581} \log Y \qquad 0.34 \quad 3.111$$

$$(4.4.16)\quad \log\left(\frac{qs}{qa}\right) = -0.0719 - \underset{(0.9164)}{1.7120} \log\left(\frac{Ps}{Pa}\right) + \underset{(0.0444)}{0.0057t} \qquad 0.33 \quad 3.119$$

$$(4.4.17)\quad \log\left(\frac{qs}{qa}\right) = -14.4676 - \underset{(1.0029)}{1.8449} \log\left(\frac{Ps}{Pa}\right) + \underset{(13.8496)}{6.0628} \log Y - \underset{(0.3279)}{0.1364t} \qquad 0.19 \quad 3.0319$$

Table (4) cont/d..

	II France		
(4.4.18)	$\log\left(\frac{qs}{qa}\right) = -5.9001 - \underset{(1.1185)}{0.9897}\log\left(\frac{Ps}{Pa}\right) + \underset{(1.0074)}{1.4392}\log Y$	0.20	1.569
(4.4.19)	$\log\left(\frac{qs}{qa}\right) = -1.0129 - \underset{(1.1585)}{0.7646}\log\left(\frac{Ps}{Pa}\right)$	0.22	1.446
(4.4.20)	$\log\left(\frac{qs}{qa}\right) = -1.1449 - \underset{(1.1469)}{0.8061}\log\left(\frac{Ps}{Pa}\right) + \underset{(0.0482)}{0.0540t}$	0.16	1.567
(4.4.21)	$\log\left(\frac{qs}{qa}\right) = -17.5935 - \underset{(1.2332)}{1.4388}\log\left(\frac{Ps}{Pa}\right) + \underset{(4.0935)}{5.0069}\log Y - \underset{(0.1891)}{0.1701t}$	0.15	1.708
	III Germany, F.R.		
(4.4.22)	$\log\left(\frac{qs}{qa}\right) = -11.2639 - \underset{(1.6373)}{3.7508}\log\left(\frac{Ps}{Pa}\right) + \underset{(1.2034)}{3.3176}\log Y$	0.67	2.328
(4.4.23)	$\log\left(\frac{qs}{qa}\right) = -0.0463 - \underset{(2.0658)}{3.7508}\log\left(\frac{Ps}{Pa}\right)$	0.36	1.492
(4.4.24)	$\log\left(\frac{qs}{qa}\right) = -0.5003 - \underset{(1.6571)}{3.5864}\log\left(\frac{Ps}{Pa}\right) + \underset{(0.0699)}{0.1865t}$	0.66	2.406
	IV Italy		
(4.4.25)	$\log\left(\frac{qs}{qa}\right) = 76.1887 - \underset{(2.2791)}{1.9194}\log\left(\frac{Ps}{Pa}\right) - \underset{(16.9528)}{32.9530}\log Y + \underset{(0.9997)}{0.2060t}$	0.42	2.405
(4.4.26)	$\log\left(\frac{qs}{qa}\right) = -0.8509 - \underset{(2.4954)}{0.2836}\log\left(\frac{Ps}{Pa}\right)$	0.30	2.026
(4.4.27)	$\log\left(\frac{qs}{qa}\right) = -5.3616 - \underset{(2.4995)}{0.4953}\log\left(\frac{Ps}{Pa}\right) + \underset{(1.7959)}{1.8318}\log Y$	0.29	2.275
(4.4.28)	$\log\left(\frac{qs}{qa}\right) = 1.09981 - \underset{(2.4619)}{0.6140}\log\left(\frac{Ps}{Pa}\right) + \underset{(0.1040)}{0.1250t}$	0.22	2.296

APPENDEX B

Appendix B

Table I

Annual Growth rates of the variables used in the study of cotton output (irrigated) in Sudan 1945/46-1963/64.

(Regression results: $X = ab^t$)

Variables	Gezira scheme				Private estates		All Sudan	
	1945/46-1963/64		1950/51-1963/64		1945/46-1963/64		1945/46-1963/64	
	b%	$\bar{R}^2$	b%	$\bar{R}^2$	b%	$\bar{R}^2$	b%	$\bar{R}^2$
Total output	4.40	0.25	4.1*	0.05	21.6	0.89	7.0	0.56
Acreage	5.5	0.81	7.7	0.87	20.3	0.93	7.65	0.96
No. of pickers (L_p)	1.64*	0.06	0.6*	-0.07				
Total supply of fertilizers (F_q)							26.6	0.71
Total supply of insecticides (I_q)							20.0	0.74
Value of total supply of fertilizers (F')							23.5	0.72
Value of total supply of insecticides (I')							27.2	0.82
Expenditure on fertilizers (F)			13.1	0.85				
Expenditure on insecticides (I)			10.4	0.22				
Expenditure on management (M)			10.3	0.67				
Expenditure per feddon of fertilizer $(\frac{F}{A})$			4.5	0.37				
Expenditure per feddon on Insecticides $(\frac{I}{A})$			2.4*	-0.05				
Expenditure per feddon on management $(\frac{M}{A})$			2.4	0.20				
Yield per feddon $(\frac{Y}{A})$	-0.12*	-0.03	-3.39*	0.04				
Tenants profit share (R)	-1.3*	-0.05	-3.99*	-0.04				
Size of cotton tenancy (Z)	-1.53	0.80	-2.12	0.85				
Cotton stocks (S)	4.7	0.26	10.1	0.53				

* Insignificant. All other growth rate (b's) are significant at 5%.

Appendix B

Table 2 All Sudan ELS Cotton 1945/46 - 1963/64

Matrix of Simple Correlation Coefficients

Variable	Y'	P	S	A'	F'	I'	W_t
Y'	1.000	-0.553	0.277	0.774	0.793	0.736	0.394
P		1.000	-0.266	-0.576	-0.670	-0.380	-0.268
S			1.000	0.652	0.547	0.715	0.605
A'				1.000	0.946	0.884	0.141
F'					1.000	0.790	0.121
I'						1.000	-0.009
W_t							1.000

N.B. Any value greater than 0.45 is significant at 5% level.

Appendix B

Table 3 Gezira ELS Cotton 1945-64

Matrix of Simple Correlation Coefficients

	Y	R	S	A	W_t	L_p	Z	Tim
Y	1.000	0.412	0.133	0.631	0.448	0.801	-0.585	0.59
R		1.000	-0.340	-0.031	0.260	0.290	0.075	-0.08
S			1.000	0.622	0.005	-0.205	-0.638	0.60
A				1.000	0.053	0.312	-0.955	0.87
W_t					1.000	0.305	-0.130	0.17
L_p (No. of pickers)						1.000	-0.322	0.38
Z							1.000	-0.90
Time								1.00

Any value greater than 0.45 is significant at 5% level.

Appendix B

Table 4 Gezira ELS Cotton 1945/46-1963/64

Simple Correlation Coefficients (Labour)

Variables	According to Assumption I of 300 day work (in man/hrs.)			Assumption II of 275days(in man/hrs)	No. of Cotton Pickers (Person)
	All Labour (L)	Family Labour (L_f)	Picking Labour (L_p)	All Labour (L)	
Y	0.852	0.625	0.801	0.855	0.801
R	0.117	-0.035	0.290	0.120	0.290
S	0.361	0.630	-0.206	0.354	-0.205
A	0.886	1.000	0.312	0.881	0.312
W_t	0.188	0.052	0.305	0.190	0.305

Table (5) SUDAN GEZIRA SCHEME L.S. COTTON 1950/51-1963/64 Appendix (B)

Matrix of Correlation Coefficients

Y	R	P	S	A	L_p	F	I	M	Z	W_t	W_s	W_{t-1}	Time
1.000	0.395	-0.295	0.055	0.537	0.786	0.556	0.495	0.521	-0.467	0.428	0.376	-0.523	0.437
	1.000	0.550	-0.360	-0.107	0.238	-0.161	-0.054	-0.069	0.162	0.277	0.301	-0.293	0.329
		1.000	-0.253	-0.375	-0.373	-0.546	-0.180	-0.345	0.458	-0.225	-0.101	0.030	-0.568
			1.000	0.613	-0.278	0.636	0.583	0.562	-0.630	-0.055	-0.116	0.206	0.740
				1.000	0.196	0.930	0.842	0.983	-0.950	-0.042	-0.294	0.111	0.923
					1.000	0.269	0.035	0.146	-0.200	0.307	0.380	-0.407	0.192
						1.000	0.706	0.890	-0.956	0.097	-0.198	0.086	0.950
							1.000	0.871	-0.714	-0.194	-0.251	-0.230	0.676
								1.000	-0.927	-0.049	-0.299	0.073	0.862
									1.000	-0.021	0.237	-0.144	-0.929
										1.000	0.797	-0.298	0.064
											1.000	-0.606	-0.197
												1.000	0.216
													1.000

Any value greater than $\begin{cases} 0.46 \text{ is significant at 10\% level} \\ 0.53 \text{ is significant at 5\% level} \end{cases}$

Table (6)

ELS Cotton Supply Response
In Gezira and Private Pump Schemes
1945/46 - 1963/64

Appendix B

Eq. No.		$\bar{R}$	$\frac{\delta^2}{S^2}$
	I Acreage response function		
	(P_{t-1})		
(5.2.1)	$\log A = 0.1402 + \underset{(0.1007)}{0.0900} \log P_{t-1} + \underset{(0.1186)}{0.8651} \log A_{t-1} + \underset{(0.0776)}{0.0154}t$	0.98	1.221
(5.2.2)	$\log \ddot{A} = 0.0965 - \underset{(0.2519)}{0.0073} \log P_{t-1} + \underset{(0.1691)}{1.0119} \log \ddot{A}_{t-1} - \underset{(0.0316)}{0.0112}t$	0.98	1.368
	(P_{t-2})		
(5.2.3)	$\log A = 0.2475 + \underset{(0.1046)}{0.0769} \log P_{t-2} + \underset{(0.1248)}{0.8270} \log A_{t-1} + \underset{(0.0088)}{0.0187}t$	0.98	1.301
(5.2.4)	$\log \ddot{A} = 0.1104 - \underset{(0.2437)}{0.0286} \log P_{t-2} + \underset{(0.1622)}{1.0433} \log \ddot{A}_{t-1} - \underset{(0.0319)}{0.0216}t$	0.99	1.555
	(P_{t-3})		
(5.2.5)	$\log A = 0.4326 - \underset{(0.1117)}{0.0335} \log P_{t-3} + \underset{(0.1428)}{0.8351} \log A_{t-1} + \underset{(0.0107)}{0.0154}t$	0.98	1.249
(5.2.6)	$\log \ddot{A} = 0.1192 - \underset{(0.2358)}{0.0398} \log P_{t-3} + \underset{(0.1577)}{1.0620} \log \ddot{A}_{t-1} - \underset{(0.0313)}{0.0304}t$	0.98	1.827

Table (6) Cont/d..

	(3 years moving average, $\dot{P}$)		
(5.2.7)	$\log A = 0.0599 + \underset{(0.2104)}{0.2715} \log \dot{P} + \underset{(0.1352)}{0.7545} \log A_{t-1} + \underset{(0.0123)}{0.0287t}$	0.98	1.362
(5.2.8)	$\log \ddot{A} = 1.3494 - \underset{(0.5380)}{0.6205} \log \dot{P} + \underset{(0.2013)}{0.8917} \log \ddot{A}_{t-1} - \underset{(0.0321)}{0.0101t}$	0.98	1.545
	Distributed lag 2 - 1 : ($\ddot{P}$)		
(5.2.9)	$\log A = 0.1485 + \underset{(0.1502)}{0.1601} \log \ddot{P} + \underset{(0.1254)}{0.8058} \log A_{t-1} + \underset{(0.0096)}{0.0219t}$	0.96	1.292
(5.2.10)	$\log \ddot{A} = 0.1567 - \underset{(0.3803)}{0.5113} \log \ddot{P} + \underset{(0.1770)}{1.0373} \log \ddot{A}_{t-1} - \underset{(0.0324)}{0.0209t}$	0.98	1.543
	Distributed lag 3-2-1 :($\dddot{P}$)		
(5.2.11)	$\log A = 0.0657 + \underset{(0.1930)}{0.3562} \log \dddot{P} + \underset{(0.1422)}{0.6852} \log A_{t-1} + \underset{(0.0135)}{0.0376t}$	0.98	1.343
(5.2.12)	$\log \ddot{A} = 0.4994 - \underset{(0.4906)}{0.2208} \log \dddot{P} + \underset{(0.1889)}{1.0180} \log \ddot{A}_{t-1} - \underset{(0.0317)}{0.0279t}$	0.99	1.897
	Distributed lag 4-3-2-1: ($\ddddot{P}$)		
(5.2.13)	$\log A = 0.0368 + \underset{(0.2554)}{0.5010} \log \ddddot{P} + \underset{(0.1688)}{0.5860} \log A_{t-1} + \underset{(0.0181)}{0.0506t}$	0.98	1.252
(5.2.14)	$\log \ddot{A} = 0.3072 - \underset{(0.5172)}{0.1138} \log \ddddot{P} + \underset{(0.1699)}{1.0348} \log \ddot{A}_{t-1} - \underset{(0.0258)}{0.0357t}$	0.99	2.667

Table (6) Cont/d..

II Yield supply functions

(5.2.15) $$\log\left(\frac{Y}{A}\right) = \underset{}{8.1075} - \underset{(0.3928)}{1.2284} \log P_{t-1} - \underset{(0.1542)}{0.4478} \log S_t - \underset{(0.4691)}{1.7602} \log W_{t-1} - \underset{(0.3239)}{0.2275} \log W_s - \underset{(0.0167)}{0.0106t} \qquad 0.80 \quad 2.709$$

(5.2.16) $$\log\left(\frac{Y''}{A''}\right) = 2.2248 - \underset{(0.3815)}{0.8486} \log P_{t-1} - \underset{(0.1702)}{0.4343} \log S_t + \underset{(0.0186)}{0.0051t} \qquad 0.56 \quad 2.306$$

(5.2.17) $$\log\left(\frac{Y}{A}\right) = -2.4801 + \underset{(0.0838)}{0.3166} \log\left(\frac{R}{A}\right) + \underset{(0.3522)}{0.8099} \log W_t - \underset{(0.1463)}{0.1288} \log S_t - \underset{(0.0102)}{0.0127t} \qquad 0.85 \quad 1.891$$

(5.2.18) $$\log\left(\frac{Y}{A}\right) = -2.8387 + \underset{(0.0579)}{0.3252} \log\left(\frac{R}{A}\right) + \underset{(0.3215)}{0.8421} \log W_t \qquad 0.85 \quad 1.967$$

Table (7) ALL SUDAN ELS COTTON PRODUCTION FUNCTION Appendix (B)

(Cobb-Douglas)

1945/46-1963/64

Eq. No.		$\bar{R}$	$\frac{\delta^2}{S^2}$
(5.3.1)	$\text{Log } Y' = -4.6188 + \underset{(1.4312)}{1.5906} \log A' + \underset{(0.5282)}{1.0471} \log W_t + \underset{(0.1192)}{0.1486} \log F_q - \underset{(0.0479)}{0.0471} \log I_q - \underset{(0.1103)}{0.0704}\, t$	0.77	2.389
(5.3.2)	$\log Y' = -2.4915 + \underset{(0.1731)}{0.8405} \log A' + \underset{(0.4994)}{1.0146} \log W_t$	0.79	2.197
(5.3.3)	$\log Y' = -2.1952 + \underset{(0.2116)}{0.6846} \log A' + \underset{(0.4921)}{1.0027} \log W_t + \underset{(0.0709)}{0.0866} \log \left(\frac{F}{A'}\right)_q$	0.80	2.344
(5.3.4)	$\text{Log } Y' = -2.5591 + \underset{(0.3025)}{0.8799} \log A' + \underset{(0.5195)}{1.0041} \log W_t - \underset{(0.1593)}{0.0256} \log \left(\frac{I}{A'}\right)_q$	0.77	2.206
(5.3.5)	$\text{Log } Y' = -1.6179 + \underset{(0.8542)}{0.4768} \log A' + \underset{(0.5141)}{0.9976} \log W_t + \underset{(0.0645)}{0.0281}\, t$	0.78	2.274

Table 8 | Appendix B

GEZIRA SCHEME

ELS Cotton production and yield functions

Cobb-Douglas

1945/46 - 1963/64 and 1950/51 - 1963/64

Production:
(a) (1945/46-1963/64)

	Equation	$\bar{R}$	δ^2/S^2
(5.3.6)	$\log Y = -4.6922 + \underset{(0.4450)}{1.3627} \log A + \underset{(0.2413)}{0.8704} \log L_p + \underset{(0.4189)}{0.8688} \log W_t - \underset{(0.0536)}{0.0205} \log F_q - \underset{(0.1216)}{0.2149} \log I_q$	0.84	2.053
(5.3.7)	$\log Y = -5.0493 + \underset{(0.4266)}{1.1844} \log A + \underset{(0.2290)}{0.8369} \log L_p + \underset{(0.4290)}{0.9889} \log W_t - \underset{(0.0258)}{0.0380}t$	0.84	1.686
(5.3.8)	$\log Y = -3.3706 + \underset{(0.1891)}{0.6149} \log A + \underset{(0.2342)}{0.7784} \log L_p + \underset{(0.4378)}{0.8715} \log W_t'$	0.82	1.757
(5.3.9)	$\log Y = 1.1103 + \underset{(0.2079)}{0.7023} \log A + \underset{(0.2577)}{0.7199} \log L_p - \underset{(0.4909)}{0.9629} \log W_{t-1} + \underset{(0.3007)}{0.0981} \log W_s$	0.81	2.393
(5.3.10)	$\log Y = -10.5258 + \underset{(0.7882)}{1.8769} \log A + \underset{(0.2244)}{0.7237} \log L_p + \underset{(0.4207)}{0.9854} \log W_t + \underset{(2.6798)}{4.4058} \log Z$	0.84	2.181

Production:
(b) (1950/51-1963/64)

	Equation	$\bar{R}$	δ^2/S^2
(5.3.11)	$\log Y = -7.4638 + \underset{(1.0565)}{0.4719} \log A + \underset{(0.2292)}{0.7995} \log L_p + \underset{(0.4584)}{1.1375} \log W_t + \underset{(0.3305)}{0.2971} \log F + \underset{(0.1852)}{0.4686} \log I - \underset{(0.6938)}{0.2136} \log M + \underset{(3.8036)}{2.7250} \log Z$	0.89	2.462

Table 8 Cont/d..

(5.3.12)	$\log Y = -3.6627 + \underset{(0.9052)}{0.1243} \log A + \underset{(0.2121)}{0.8457} \log L_p + \underset{(0.4276)}{1.2212} \log W_t + \underset{(0.2552)}{0.1488} \log F + \underset{(0.1590)}{0.5291} \log I - \underset{(0.5979)}{0.4369} \log M$	0.90	2.731
(5.3.13)	$\log Y = -7.0484 + \underset{(0.6585)}{1.9880} \log A + \underset{(0.2672)}{0.7277} \log L_p + \underset{(0.5085)}{1.1422} \log W_t - \underset{(0.0520)}{0.1136}t$	0.83	1.898
(5.3.14)	$\log Y = -3.4999 + \underset{(0.2605)}{0.6337} \log A + \underset{(0.3100)}{0.8163} \log L_p + \underset{(0.5784)}{0.8687} \log W_t$	0.76	1.551
(5.3.15)	$\log Y = 1.1266 + \underset{(0.2686)}{0.7082} \log A + \underset{(0.3158)}{0.6928} \log L_p - \underset{(0.6794)}{1.0659} \log W_{t-1} + \underset{(0.7011)}{0.2228} \log W_s$	0.78	2.367
(5.3.16)	$\log Y = -3.5002 + \underset{(0.3157)}{0.6370} \log A + \underset{(0.3274)}{0.8168} \log L_p + \underset{(0.6181)}{0.8709} \log W_t - \underset{(0.3631)}{0.0077} \log \left(\frac{F}{A}\right)_c$	0.73	1.554
(5.3.17)	$\log Y = -3.9933 + \underset{(0.3079)}{0.7151} \log A + \underset{(0.3260)}{0.8465} \log L_p + \underset{(0.6319)}{0.9784} \log W_t - \underset{(0.3833)}{0.2111} \log \left(\frac{F}{A}\right)$	0.74	1.756
(5.3.18)	$\log Y = -3.6293 + \underset{(0.1766)}{0.3286} \log A + \underset{(0.1913)}{0.8491} \log L_p + \underset{(0.3652)}{1.1953} \log W_t + \underset{(0.0975)}{0.4057} \log \left(\frac{I}{A}\right)$	0.92	2.646
(5.3.19)	$\log Y = -5.1774 + \underset{(0.2688)}{0.4128} \log A + \underset{(0.2962)}{0.9522} \log L_p + \underset{(0.9591)}{0.5364} \log W_{t-1} + \underset{(0.7471)}{1.1625} \log W_s + \underset{(0.2102)}{0.4405} \log \left(\frac{I}{A}\right)$	0.84	2.334

Table 8 Cont/d..

(5.3.20) $$\log Y = -2.9304 + \underset{(0.3615)}{0.2751} \log A + \underset{(0.2978)}{0.8446} \log L_p + \underset{(0.5545)}{0.8558} \log W_t + \underset{(0.6047)}{0.8297} \log \left(\frac{M}{A}\right) \qquad 0.78 \quad 1.793$$

(5.3.21) $$\log Y = -11.4187 + \underset{(1.0513)}{2.0337} \log A + \underset{(0.2994)}{0.7662} \log L_p + \underset{(0.5577)}{0.9498} \log W_t + \underset{(3.6308)}{4.9773} \log Z \qquad 0.78 \quad 2.136$$

Yield:
(c) <u>(1950/51-1963/64)</u>

(5.3.22) $$\log \left(\frac{Y}{A}\right) = -3.1232 + \underset{(0.1592)}{0.7562} \log \left(\frac{L}{A}\right)p + \underset{(0.3810)}{1.1867} \log W_t + \underset{(0.2074)}{0.2652} \log \left(\frac{F}{A}\right) + \underset{(0.1370)}{0.5346} \log \left(\frac{I}{A}\right)$$
$$- \underset{(0.4600)}{0.3679} \log \left(\frac{M}{A}\right) \qquad 0.90 \quad 2.585$$

(5.3.23) $$\log \left(\frac{Y}{A}\right) = -3.0328 + \underset{(0.1401)}{0.8122} \log \left(\frac{L}{A}\right)p + \underset{(0.3605)}{1.1076} \log W_t + \underset{(0.1991)}{0.2321} \log \left(\frac{F}{A}\right) + \underset{(0.0923)}{0.4550} \log \left(\frac{I}{A}\right) \qquad 0.90 \quad 2.576$$

(5.3.24) $$\log \left(\frac{Y}{A}\right) = -5.2168 + \underset{(0.2257)}{0.8954} \log \left(\frac{L}{A}\right)p + \underset{(0.8810)}{0.7843} \log W_{t-1} + \underset{(0.6751)}{1.2293} \log W_s + \underset{(0.2420)}{0.4426} \log \left(\frac{F}{A}\right)$$
$$+ \underset{(0.2005)}{0.5826} \log \left(\frac{I}{A}\right) \qquad 0.85 \quad 2.261$$

(5.3.25) $$\log \left(\frac{Y}{A}\right) = -3.4569 + \underset{(0.1616)}{0.7164} \log \left(\frac{L}{A}\right)p + \underset{(0.3780)}{1.3254} \log W_t + \underset{(0.1353)}{0.4822} \log \left(\frac{I}{A}\right) - \underset{(0.4664)}{0.2507} \log \left(\frac{M}{A}\right) \qquad 0.89 \quad 2.736$$

(5.3.26) $$\log \left(\frac{Y}{A}\right) = -2.7958 + \underset{(0.2368)}{0.5519} \log \left(\frac{L}{A}\right)p + \underset{(0.6568)}{1.0078} \log W_t + \underset{(0.3537)}{0.0073} \log \left(\frac{F}{A}\right) \qquad 0.63 \quad 1.850$$

Table 8 Cont/d..

(5.3.27)	$\log\left(\frac{Y}{A}\right) = 3.0122 + \underset{(0.2392)}{0.4885} \log\left(\frac{L}{A}\right)p + \underset{(0.3084)}{0.2082} \log\left(\frac{F}{A}\right) - \underset{(0.6868)}{1.3068} \log W_{t-1} + \underset{(0.7377)}{0.0752} \log W_s$	0.69	2.441
(5.3.28)	$\log\left(\frac{Y}{A}\right) = -3.3633 + \underset{(0.1350)}{0.7597} \log\left(\frac{L}{A}\right)p + \underset{(0.3430)}{1.2570} \log W_t + \underset{(0.0915)}{0.4304} \log\left(\frac{I}{A}\right)$	0.91	2.711
(5.3.29)	$\log\left(\frac{Y}{A}\right) = -3.9514 + \underset{(0.2374)}{0.7511} \log\left(\frac{L}{A}\right)p + \underset{(0.2123)}{0.4604} \log\left(\frac{I}{A}\right) + \underset{(0.9637)}{0.4214} \log W_{t-1} + \underset{(0.7559)}{1.1413} \log W_s$	0.80	2.313
(5.3.30)	$\log\left(\frac{Y}{A}\right) = -2.7078 + \underset{(0.2352)}{0.8056} \log\left(\frac{L}{A}\right)p + \underset{(0.5237)}{0.8678} \log W_t + \underset{(0.4822)}{0.9340} \log\left(\frac{M}{A}\right)$	0.75	1.905
(5.3.31)	$\log\left(\frac{Y}{A}\right) = -2.8350 + \underset{(0.1957)}{0.8321} \log\left(\frac{L}{A}\right)p + \underset{(0.3692)}{1.2051} \log W_t + \underset{(0.0956)}{0.4245} \log\left(\frac{I}{A}\right) - \underset{(0.8208)}{0.4356} \log Z$	0.89	2.700

APPENDEX C

Table (1) **PRICE FORMATION OF SUDAN COTTON (ELS)** Appendix (C)

1953 - 1965

Eq. No.	I. 1953-65	$\bar{R}^2$	$\frac{\delta^2}{S^2}$
(6.1)	$P_s = 31.3397 + \underset{(0.08885)}{0.8661}\,P_e$	0.887	1.635
(6.2)	$P_s = -9.8428 + \underset{(0.1017)}{1.2371}\,P_p$	0.92	1.306
(6.3)	$P_s = 15.802 + \underset{(0.5743)}{1.0888}\,P_a$	0.177	1.687
(6.4)	$P_s = 56.4189 - \underset{(0.0163)}{0.0255}\,S_{(t)}$	0.11	1.072
(6.5)	$P_s = -6.8247 + \underset{(0.1507)}{0.3611}\,P_e + \underset{(0.2113)}{0.7736}\,P_p$	0.947	1.681
(6.6)	$P_s = 3.4577 + \underset{(0.1094)}{0.8701}\,P_e - \underset{(0.2625)}{0.0181}\,P_a$	0.876	1.630
(6.7)	$P_s = -7.6281 + \underset{(0.1800)}{0.3481}\,P_e + \underset{(0,2367)}{0.7787}\,P_p + \underset{(0.1988)}{0.0424}\,P_a - \underset{(0.00515)}{0.00003}\,S_t$	0.93	1.713
(6.8)	$P_s = -6.6068 + \underset{(0.1641)}{0.3583}\,P_e + \underset{(0.2231)}{0.7744}\,P_p - \underset{(0.00471)}{0.00031}\,S_t$	0.94	1.671
(6.9)	$P_s = 2.9785 + \underset{(0.1207)}{0.8726}\,P_e - \underset{(0.2865)}{0.0128}\,P_a + \underset{(0.00744)}{0.00052}\,S_t$	0.86	1.624

Table (1) cont/d.. II. <u>1953-1963</u>

(6.10)	$P_s = 59.3258 - \underset{(0.00197)}{0.00283}\, C_2$	0.096	1.542
(6.11)	$P_s = 58.4198 - \underset{(0.00185)}{0.00238}\, C_1$	0.06	1.502
(6.12)	$P_s = -\ 8.9340 + \underset{(0.2331)}{0.2168}\, P_e + \underset{(0.3223)}{0.9775}\, P_p - \underset{(0.00853)}{0.00136}\, S_t + \underset{(0.000756)}{0.000026}\, C_1$	0.94	1.821
(6.13)	$P_s = -\ 8.4031 + \underset{(1.2316)}{0.2296}\, P_e + \underset{(0.3218)}{0.9572}\, P_p - \underset{(0.00866)}{0.00018}\, S_t - \underset{(0.00085)}{0.00012}\, C_2$	0.94	1.876
(6.14)	$P_s = -15.8066 + \underset{(0.2713)}{0.0915}\, P_e + \underset{(0.3531)}{1.1043}\, P_p + \underset{(0.2398)}{0.2236}\, P_a - \underset{(0.00863)}{0.00156}\, S_t + \underset{(0.00078)}{0.00018}\, C_1$	0.94	2.418
(6.15)	$P_s = -15.5383 + \underset{(0.2763)}{0.0995}\, P_e + \underset{(0.3604)}{1.0932}\, P_p + \underset{(0.2471)}{0.2222}\, P_a - \underset{(0.00886)}{0.00101}\, S_t + \underset{(0.00091)}{0.00013}\, C_2$	0.94	2.424

APPENDEX D

Table (1) Instability Indices for some of Sudan's Main Economic Indicators 1948-1965 Appendix (D)

	(1) EXPORTS				(2)	(3)	(4) IMPORTS		(5) Gross Domestic Product (at factor cost)		(6)
		COTTON			Gezira's tenants income from cotton	Government Revenue		Capital goods + Building R.M.		Modern (money) sector	Gross fixed Investment
	Total (LS million)	Value (LS million)	Volume (000's M.T.)	unit value (LS/M.T.)	(LS million)	(LS million)	Total (LS million)		Total (LS million)		(LS millio
1948		15.70									
1949		19.06									
1950	33.1	22.87	62.9	363.6			27.3	4.2			
1951	62.8	47.45	90.9	522.0	17.5	46.3	42.0	5.8			
1952	42.8	28.97	51.7	560.3	6.0	30.3	61.7	10.1			
1953	44.4	26.75	90.2	296.5	4.7	35.4	50.8	12.6			
1954	40.4	21.68	60.5	358.3	6.4	38.1	48.5	10.1			
1955	50.5	30.36	94.2	322.4	5.2	42.3	48.8	10.0	284.2	123.5	19.1
1956	66.9	41.69	114.7	363.4	7.3	45.9	45.2	8.0	312.6	148.2	22.8
1957	51.4	21.24	56.7	374.6	8.6	47.4	67.6	14.8	307.9	137.9	37.3
1958	43.4	22.27	78.4	284.0	0.44	42.0	59.5	19.5	318.5	144.3	33.7
1959	66.8	40.15	179.7	223.4	6.0	67.5	57.1	12.6	346.1	165.2	36.0
1960	63.7	33.15	105.5	314.3	9.2	64.1	63.7	17.2	353.8	167.6	43.8
1961	62.2	31.15	106.2	293.3	4.0	60.3	81.5	27.0	404.6	211.3	60.3
1962	79.0	43.53	160.4	271.5	8.7	74.2	89.3	35.0	407.1	207.4	66.0
1963	78.7	45.89	179.9	255.1	7.2	78.6	97.6	30.0	409.9	203.6	81.0
1964	68.6	32.57	114.6	284.1	3.0	74.0	95.5	29.0	438.6	220.7	51.7
1965	67.9	31.20	112.0	278.6	5.3	78.1	72.2	19.5	476.5	226.4	48.4
Index of Instability (%)	(16.8)	(26.9)* (24.0)**	(30.9)	(17.3)	(44.9)	(7.0)	(14.8)	(25.2)	(5.2)	(7.6)	(15.9)

Notes

(a) Columns 1, 3, 4, 5 and 6 are based on data reported in various issues of: Economic Survey; Ministry of Finance and Economics, IMF International financial statistics and U.N. Year Book of International Trade Statistics.

(b) Column 2 is derived from Sudan Gezira Board annual statements of Accounts.

(c) Instability index is the average percent change (ignoring signs) of deviations, using the U.N. method of taking always the higher figure of the two years in the denominator.

* Instability index between 1948 and 1960.

** Instability index between 1950 and 1965

Appendix D

Table 2 TOTAL AREA OF MAIN CROPS

By Types of Irrigation 1953/54 - 1962/63

(feddons: feddon = 1.035 acres)

CROP YEAR	IRRIGATION	RAIN	FLOOD	TOTAL
1953/54	513,170	4,211,412	190,744	4,915,326
1954/55	559,752	4,117,000	143,851	4,820,603
1955/56	628,815	4,648,403	68,175	5,345,393
1956/57	724,708	4,834,103	262,168	5,820,979
1957/58	739,550	4,575,668	106,157	5,421,379
1958/59	891,065	5,365,761	203,233	6,460,059
1959/60	999,177	5,355,270	192,509	6,546,956
1960/61	1,140,600	5,028,349	118,491	6,287,440
1961/62	1,242,386	5,500,090	266,113	7,008,589
1962/63	1,242,225	5,980,230	110,846	7,333,301
1963/64	1,295,983	6,567,160	125,645	7,988,788

Source: Bulletin of Agricultural Statistics, Ministry of Agriculture, Khartoum, 1963 and 1964.

Appendix D

Table 3 Area and Output of Main Crops* grown by all types of irrigation

1951/52-1955/56 - 1963-1964

YEAR	COTTON		DURA		DUKHN		GROUNDNUTS		SESAME		MAIZE		WHEAT	
	Area	Output	Area	Output	Area	Output	Area	Output	Area	Output	Area	Output	Area	Output
Av 1951-52 – 1955-56	602	1765	1890	655	1302	304	141	35	385	91	33	17	31	19
56/57	736	2861	2492	1067	1269	321	460	146	793	153	41	20	30	18
57/58	701	1061	2607	1139	1006	262	449	129	563	141	64	45	31	20
58/59	854	2663	3252	1372	1004	297	464	189	747	154	106	42	33	23
59/60	908	2592	3251	1313	788	280	461	186	991	179	109	40	39	25
60/61	906	2400	3067	1051	932	226	470	192	694	127	93	31	39	26
61/62	1133	4360	3516	1434	759	205	472	149	981	232	40	7	41	29
62/63	1066	3364	3520	1245	1059	302	707	239	903	156	68	20	52	31
63/64	1050	2215	3116	1035	1369	348	886	292	1019	153	126	36	35	24

Source: Economic Survey, Ministry of Finance and Economics, Khartoum, 1963.

* Area in 000 feddans (Feddan = 1.038 acres)

Output in 000 tons, for cotton in 000 Kantars.

Dura and Dukhn are main staple food crops.

Appendix D

Table 4

Livestock (000's) head

	1955/56	1962/63
Cattle	6,907	9,100
Sheep	6,946	8,600
Goats	5,783	6,800
Camels	1,500	2,000

Source: Economic Survey, 1963, Ministry of Finance & Economics, Khartoum.

Table (5) | World Demand for ELS Cotton 1953-1965 | Appendix (D)

Year	Total annual ELS cotton exports from (000's Bales) Egypt	Sudan	Peru	(000's Bales) World Total	World total ex. exports to centrally planned ec. of E. Europe	(U.S. cents/lb) ELS cotton price c.i.f. Liverpool Egypt	Sudan	Peru	weighted av. ELS cotton price (Egypt, Sudan & Peru)	World Index of textile production 1958 = 100 All	Exc. E Europe	World index of industrial production 1958 = 100 All	Exc. E. Europe	(000's M.T.) World consumption of rayon products
1953	757.3	341.8	45.2	1144	851	55.06	53.46	47.56	52.70	82	89	78	85	1877
1954	553.9	261.8	75.4	891	841	60.05	53.54	50.95	55.64	85	90	80	85	2037
1955	613.1	475.8	74.9	1164	1042	64.65	54.41	53.49	58.13	91	96	89	95	2284
1956	513.4	303.9	107.6	925	575	72.11	69.33	63.61	68.21	95	100	94	99	2383
1957	639.4	355.7	92.5	1088	622	44.57	48.51	49.19	44.89	99	102	99	102	2478
1958	890.4	587.6	138.2	1616	973	35.70	34.59	35.76	34.28	100	100	100	100	2281
1959	1235.7	546.3	113.9	1896	1129	44.77	41.63	43.73	42.52	108	108	110	110	2524
1960	917.8	398.7	137.3	1454	742	46.91	43.54	43.71	43.93	114	110	119	118	2607
1960	782.7	590.1	128.2	1501	983	43.28	38.00	41.38	39.85	118	115	126	122	2692
1962	941.5	732.6	188.9	1863	1172	40.77	36.89	38.54	37.90	122	120	136	130	2862
1963	898.0	672.8	185.7	1757	1188	45.63	42.69	42.49	42.88	126	125	144	137	3052
1964	922.9	429.0	193.1	1545	915	51.91	47.96	43.50	48.34	133	134	155	149	3291
1965	933.2	529.8	191.7	1655	987	49.81	43.75	41.18	45.47	137	139	169	160	3291
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)

Source
Col. (1), (2) and (3) are taken from International Cotton Advisory Committee Bulletin of Cotton Statistics (I.C.A.C.), April issues of 1959, 1963 and 1966.
Col. (4) is total of (1), (2) and (3), while Col. (5) is the same total excluding Egypt's exports of ELS cotton to U.S.S.R. and E. European countries.
Col. (6), (7) and (8) are c.i.f. ELS cotton at Liverpool. Col. (9) is a weighted average of the three exporting countries according to their export's share. All are quoted from I.C.A.C.
Col. (10), (11), (12) and (13) U.N. monthly Bulletin of Statistics, various issues.
Col. (14) is quoted from: Synthetics and their effects on Agricultural Trade, Commodity Bulletin Series, F.A.O., 1964 and World apparel fibre consumption, F.A.O., 1965.

Table 6

U.K. Demand for Raw Cotton

1953-1965

Appendix D

Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Per capita of Raw Cotton lb.				Prices				US			
					Pence/lb	Cents/lb		Kg	Cent/kg.	(000's bales)	£	1958=100
1953	16.1	2.3	1.9	3.8	35.2	58.94	41.00	2.67	0.65	1,017	237	113.6
1954	17.3	2.5	1.1	3.8	34.1	53.54	37.64	3.14	0.62	877	244	115.9
1955	14.5	2.7	1.9	1.4	34.1	56.84	34.52	3.32	0.62	428	255	111.4
1956	14.9	2.2	1.4	9.4	32.39	72.90	30.04	3.56	0.62	572.6	257	109
1957	13.6	1.7	1.4	6.3	31.97	53.48	31.99	3.54	0.60	523.1	261	109
1958	11.8	1.9	1.9	1.9	34.76	45.03	34.24	3.55	0.60	395.7	265	100
1959	12.1	2.1	1.5	5.4	34.55	60.68	36.35	3.74	0.58	461.7	272	103.4
1960	11.3	1.7	1.1	3.4	34.93	57.82	36.13	4.10	0.57	353.4	287	106.8
1961	9.6	1.3	0.9	2.4	35.03	50.80	37.59	3.99	0.57	274.5	295	104.5
1962	9.3	1.3	1.0	1.2	34.69	50.40	37.17	4.26	0.56	262.2	291	100
1963	9.5	1.3	0.8	2.5	34.73	59.79	35.57	4.84	0.56	390.9	300	104.5
1964	9.5	1.2	0.5	1.3	19.48	66.24	35.70	-	0.58	291.8	314	112.2
1965	8.9	0.9	0.5	1.2	21.07	61.88	37.91	-	0.62	250.8	314	114.3

Details of Variables and Sources:

	Variable	Source
(1)	Per capita cons. of all cotton (lb.)	I.C.A.C. Bulletins 1948-1967, especially April issues.
(2)	Per capita import of ELS (Egypt and Sudan) (lb.)	
(3)	Per capita import of Sudan ELS (lb.)	
(4)	Per capita import of American cotton (lb.)	
(5)	Price of raw cotton import unit price deflated by Wholesale Price index of raw imported cotton to U.K. 1954 = 100 (Pence/lb.)	I.C.A.C. for cotton price quotations at Liverpool, F.A.O. year book for rayon fibre price and U.K. annual abstract of statistics and monthly digest of statistics for wholesale price indices.
(6)	Price of Sudan ELS Liverpool c.i.f. quotations. (cent/lb.) deflated by wholesale import of raw cotton price index 1954 = 100.	
(7)	Price of American cotton Liverpool c.i.f. quotations. (Cent/lb.) deflated by wholesale import of raw cotton price index 1954 = 100.	
(8)	Per capita cons. of synthetic fibres.	
(9)	Price of rayon staple fibre deflated by wholesale price index of rayon in U.K. 1954 = 100. (cents/kg.)	
(10)	Actual stocks of cotton at the end of the cotton year (1st August) for all cotton (000's Bales).	
(11)	Per capita disp. income at (1953=100) cost of living index U.K. (U.K. Annual Abstract and Monthly Digest of Statistics.)	
(12)	Index and Text. Prodn. 1958=100 (O.E.C.D. General stats.)	

Table 7 — France Demand for Raw Cotton 1953-65 — Appendix D

	Per Capita lb.				Deflated Liverpool c.i.f. quotations							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Year	All	Sudan ELS	Egypt ELS	U.S.A.	Sudan	Egypt	U.S.A.	Francs/lb	KG	Francs	1958 = 100	000's Bales
1953	14.9	0.123	0.892	5.10	53.46	55.06	37.19	1.47	1.51	2012	90	375
1954	14.0	0.179	1.566	4.42	55.77	62.55	39.21	1.54	1.66	2135	95.5	358
1955	13.4	0.241	1.606	1.85	55.52	65.97	33.78	1.52	1.82	2269	91.9	390
1956	14.9	0.211	0.208	4.49	67.97	70.69	28.01	1.19	2.00	2412	94.6	370
1957	15.1	0.396	0.763	3.80	45.34	41.65	27.12	1.38	2.27	2584	104.6	575
1958	12.4	0.387	0.363	2.06	31.73	32.75	24.13	1.35	2.39	2580	100	360
1959	14.4	0.332	0.653	7.02	35.28	37.94	21.13	1.20	2.48	2568	97.3	280
1960	14.5	0.170	0.489	5.72	35.98	38.77	22.49	1.20	2.74	2777	107.2	415
1961	13.5	0.191	0.670	3.10	30.40	34.62	22.50	1.19	2.92	2796	110	430
1962	12.9	0.219	0.328	1.80	29.51	32.62	21.77	1.16	3.22	2906	109	325
1963	13.0	0.217	0.432	3.77	33.35	35.65	19.84	1.08	3.66	2942	118.9	330
1964	11.8	0.111	0.471	1.83	35.26	38.17	19.01	1.05	-	3665	121.1	360
1965	12.2	0.160	0.405	1.07	31.93	36.36	19.56	1.04	-	3691	108.3	260

Note on Variables and Sources

(1) Per capita cons. of all cotton (lb.))
(2) Per capita Imports of Sudan ELS.) I.C.A.C. Monthly and Quarterly Bulletins
(3) Per capita Imports of Egypt ELS.) of cotton - world statistics.
(4) Per capita Imports of American type cotton (U.S.A.).)
(5) Price of Sudan ELS. c.i.f. Liverpool deflated by raw material wholesale price index 1953 = 100.)
(6) Price of Egypt ELS. c.i.f. Liverpool deflated by raw material wholesale price index 1953 = 100.)
(7) Price of American ELS. c.i.f. Liverpool deflated by raw material wholesale price index 1953=100.)
(8) Price of rayon fibre staple (cotton type) deflated by raw material wholesale price index 1953=100.)
(9) Per Capita cons. of synthetic fibres)

Cotton and rayon fibre prices are quoted from I.C.A.C. Bulletins. While raw material wholesale pr[illegible] index is reported in O.E.C[illegible] general statistics.

(10) Per Capita income disp. deflated by cost of living Index 1953 = 100, O.E.C.D. general statistics.
(11) Index of Text. Prodn., 1958 = 100. O.E.C.D., general statistics.
(12) All cotton stocks at the end of the period (1st Aug.), I.C.A.C.

Table (8)

Germany. W. Demand for raw cotton 1953-1965

	per capita cotton lb.				Deflated c.i.f. Liverpool price							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Year	All	Sudan	Egypt	U.S.A.	Sudan	Egypt	U.S.A.	$ Kg	Kg	D.M.	1958 = 100	(000's sales)
1953	11.8	0.143	0.670	3.646	53.46	55.06	37.19	0.73	3.70	1685	82.6	295
1954	12.0	0.175	0.842	3.232	54.08	60.66	38.02	0.71	3.24	1821	88.4	340
1955	12.5	0.514	0.412	0.665	54.79	65.11	33.34	0.70	3.22	2062	95.8	305
1956	13.4	0.224	0.392	9.551	68.99	71.75	28.43	0.70	3.30	2214	101.6	265
1957	13.2	0.382	0.087	5.542	46.78	42.98	27.98	0.68	3.33	2300	105.7	430
1958	12.4	0.643	0.353	0.919	33.98	35.07	25.83	0.60	3.37	2378	100	450
1959	13.3	0.400	1.017	5.261	41.80	44.95	25.04	0.61	3.85	2502	103	320
1960	13.4	0.349	0.262	3.752	42.19	45.45	26.37	0.59	4.22	2844	110	525
1961	12.3	0.660	0.307	1.803	35.95	40.95	26.60	0.60	4.57	2941	110	415
1962	11.3	0.743	0.350	0.879	34.51	38.14	25.45	0.60	4.80	3000	111.6	310
1963	11.2	0.811	0.590	3.440	39.17	41.86	23.30	0.59	4.97	3044	114.9	300
1964	11.2	0.529	0.546	1.852	44.41	48.06	23.94	0.59	....	3272	128.6	365
1965	10.9	0.546	0.370	0.776	39.77	45.28	24.36	0.58	...	3405	135.2	335

Notes on variables and sources

(1) per capita consumption of all cotton varieties.)
(2) per capita import of ELS cotton Sudan) I.C.A.C. Bulletins
(3) per capita import of ELS cotton Egypt)
(4) per capita import of American (type) U.S.A.)
(5) Sudan ELS cotton price cif Liverpool deflated by wholesale price index of consumers' goods industry 1953 = 100
(6) Egypt ELS cotton price cif Liverpool deflated by wholesale price index of consumers' goods industry 1953 = 100
(7) U.S.A. American type cotton price cif Liverpool deflated by wholesale price index of consumers' industry 1953 = 100
(8) Rayon fibre price deflated by wholesale price index of consumers' goods industry 1953 = 100.
(9) per capita consumption of synthetics.

)I.C.A.C. for co[t]
)prices, F.A.O.
)yearbook for ra[y]
)fibre price and
)O.E.C.D. genera[l]
)stats. for whol[e]
)sale price inde[x]
)of consumers'
)goods industry.

(10) per capita disposable income deflated by cost of living index 1953 = 100, O.E.C.D. general stats. and U.N. statistical yearbook and monthly Bulletin of Statistics.
(11) Index of textile production 1958 = 100, O.E.C.D. general statistics.
(12) Cotton stocks (all types) at the end of the period (1st August each year), I.C.A.C.

Table (9) | Italian Demand for Raw Cotton 1953-1965 | Appendix (D)

	per capita lb.				prices cents/lb.							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Year	All	Sudan ELS	Egypt ELS	U.S.A.	Sudan	Egypt	U.S.A.	$ Kg	Kg	000' lira	1958 = 100	000's Bales
1953	8.8	0.200	0.669	2.584	53.46	55.06	37.19	1.87	1.09	221	95	353
1954	8.0	0.332	0.793	2.368	53.98	60.65	38.02	1.98	1.23	224	98	300
1955	7.6	0.416	0.919	0.977	54.41	64.65	33.11	1.84	1.48	237	90.5	248
1956	8.7	0.254	0.533	6.775	67.97	70.70	28.01	1.68	1.63	260	95	228
1957	8.5	0.016	0.297	5.380	47.10	43.27	28.17	1.48	1.88	281	104.8	345
1958	6.5	0.461	0.369	1.441	34.25	35.35	26.04	1.49	2.04	292	100	374
1959	9.9	0.449	0.787	5.721	42.48	45.68	25.45	1.44	2.19	308	110.5	278
1960	10.0	0.410	0.381	4.355	43.98	47.38	27.48	1.47	2.24	325	120.9	433
1961	10.0	0.701	0.560	3.597	38.38	43.72	28.40	1.47	2.26	351	120.0	380
1962	10.2	0.732	0.474	1.822	36.17	39.97	26.68	1.52	2.98	376	129.5	365
1963	10.0	0.686	0.548	4.168	39.90	42.64	23.74	1.55	3.29	399	133.3	360
1964	8.3	0.327	0.476	2.430	43.25	46.81	23.31	1.51	-	414	125.7	390
1965	9.3	0.541	0.431	0.950	38.85	44.24	23.80	1.48	-	419	112.4	275

Notes on variables and sources

(1) per capita consumption of all cotton varieties.
(2) per capita imports of ELS Sudan cotton.
(3) per capita imports of ELS Egypt cotton.
(4) per capita imports of American type cotton.
} I.C.A.C. Bulletins

(5) Price of Sudan ELS c.i.f. Liverpool deflated by wholesale price index 1953 = 100.
(6) Price of Egypt ELS c.i.f. Liverpool deflated by wholesale price index 1953 = 100.
(7) Price of American c.i.f. Liverpool deflated by wholesale price index 1953 = 100.
(8) Price of rayon fibre (equivalent to cotton) wholesale price ($/Kg) deflated by wholesale price index 1953 = 100.
(9) per capita consumption of synthetic.
} I.C.A.C. for cotton prices, F.A.O. year book and Industrial fibres for rayon price and O.E.C.D. general statistics for the wholesale price index.

(10) per capita income (G.N.P. at factor cost) deflated by cost of living index 1953 = 100. O.E.C.D. general statistics and U.N. statistical year book.

(11) Index of textile production 1958 = 100. O.E.C.D. general statistics.
(12) All cotton varieties stocks at the end of the period (1st August each year) I.C.A.C.

Table (10) — India Demand for Raw Cotton 1953-1965 — Appendix (D)

Year	(1) per capita cons. of all cotton lb.	(2) Bales 000's Sudan ELS	(3) Bales 000's U.A.R. ELS	(4) Deflated prices (Bombay) India Jarilla fine	(5) c.i.f. Liverpool U.S.A.	(6) Sudan	(7) Egypt	(8) lb.	(9) rupees	(10) 100 crores	(11) 1956 = 100	(12) (000 Bales)
1953	5.0	33.7	182.6	19.90	37.95	54.55	56.18	0.108	281	104.8	87.4	1625
1954	4.9	68.0	129.5	16.41	35.85	50.99	57.19	0.110	267	101.2	88.8	1422
1955	5.0	104.1	163.8	18.22	30.94	50.85	60.42	0.147	287	110.9	95.4	1464
1956	5.2	51.3	47.3	18.30	25.06	60.81	63.25	0.173	290	114.2	100	1248
1957	4.9	68.3	56.0	15.88	24.18	40.42	37.14	0.156	272	109.5	100.8	1113
1958	4.8	99.2	54.6	17.06	24.13	31.73	32.75	0.163	281	115.6	100.1	1230
1959	4.8	109.5	167.9	19.79	22.67	37.84	40.70	0.209	271	113.5	101.2	1246
1960	4.9	60.9	76.1	15.66	19.57	31.32	33.74	0.199	285	122.4	103.0	1534
1961	5.2	152.0	74.0	14.51	18.75	25.33	28.85	0.198	275	119.8	108.5	1223
1962	4.9	128.2	111.7	18.78	21.26	28.82	31.85	0.283	270	121.3	109.4	1556
1963	5.2	99.5	113.5	18.89	19.24	32.34	34.57	0.305	268	123.2	115.6	1661
1964	5.3	73.9	104.8	18.14	18.46	34.26	37.08	0.394	286	135	123.3	1730
1965	4.7	101.2	124.2	–	–	–	–	0.422	246	119.0	–	1476

Notes on variables and sources

(1) per capita consumption of all cotton varieties.)
(2) Total imports of Sudan ELS cotton.) I.C.A.C. Bulletins.
(3) Total imports of Egypt ELS cotton.)
(4) Wholesale price of India's Jarilla fine cotton at Bombay deflated by fibre wholesale price index 1952 = 100.) I.C.A.C. and F.A.O. year book for cotton prices and Indian monthly abstract of statistics for fibre wholesale price index.
(5) U.S.A. American type cotton price c.i.f. Liverpool deflated by fibre wholesale price index 1952-1955 = 100.
(6) Sudan ELS cotton price c.i.f. Liverpool deflated by fibre wholesale price index 1952-1955 =100)
(7) Egypt's ELS cotton price c.i.f. Liverpool deflated by fibre wholesale price index 1952-1955 = 100)
(8) Per capita consumption of rayon piece goods (India's monthly abstract of statistics).
(9) Per capita income deflated by cost of living index 1953 = 100.) India abstract of statistics and U.N.
(10) Total income deflated by cost of living index 1953 = 100.) year book and monthly Bulletin of
(11) Index of cotton textile production 1956 = 100.) Statistics.
(12) Cotton stocks (all types) as at 1st August each year. (I.C.A.C.)

Table (11) Data Series Used in Estimates of Production Supply and yield of Sudan ELS cotton Appendix (D)

	OUTPUT (000's M.T.)			ACREAGE (000's feddan)			YIELD (M.T/feddan)		RAINFALL (m.m.)		(US cents/lb)	(000's) LS	(000's Bales)
	All Sudan	Gezira scheme	Private Estates	Sudan	Gezira	Private Estates	Gezira	Private Estates	Annual Total	Pre-sowing (J - Aug.)	Deflated ELS cotton price	Deflated Gezira Tenants' profit share	Cotton stocks (all types)
1945/46	105	94	5.2	229	197	14	0.476	0.379	414.3	262.1	61.36	2176	340
1946	129	115	7.2	237	207	15	0.557	0.488	409.7	206.1	53.39	4000	250
1947	121	100	7.1	244	207	16	0.480	0.453	331.1	195.3	72.27	5060	240
1948	146	125	8.8	245	208	16	0.603	0.548	438.7	229.5	69.27	5404	220
1949	161	134	11.1	251	209	20	0.644	0.561	385.3	130.9	43.21	6099	185
1950	242	209	22.7	256	208	24	1.003	0.945	427.1	295.9	70.78	19510	160
1951	123	97	13.2	289	222	34	0.439	0.386	363.5	253.8	67.34	5695	225
1952	202	156	28.8	314	235	50	0.666	0.573	367.3	270.3	47.71	4724	90
1953	205	156	40.2	316	235	57	0.664	0.708	452.3	297.9	39.72	3520	220
1954	212	142	54.4	351	235	91	0.607	0.595	408.7	274.6	40.96	2775	220
1955	247	165	72.0	370	239	106	0.689	0.683	399.9	249.7	39.95	3930	325
1956	359	235	105.4	414	245	141	0.957	0.750	512.1	318.6	46.97	4112	270
1957	99	52	39.4	443	245	169	0.213	0.233	383.0	271.6	48.13	374	545
1958	328	207	108.4	535	311	198	0.667	0.548	480.1	338.9	37.64	5484	365
1959	333	228	111.5	609	385	195	0.559	0.592	568.9	297.9	43.14	9115	265
1960	301	166	123.2	653	429	197	0.386	0.652	302.9	179.5	43.85	3672	250
1961	563	393	153.5	699	468	204	0.841	0.754	437.1	302.1	38.35	7779	330
1962	417	264	139.8	720	484	208	0.545	0.672	417.8	274.6	43.92	5619	670
1963/64	271	165	92.8	740	508	200	0.324	0.463	379.3	228.6	46.60	2305	600
	(Y^1)	(Y)	(Y'')	(A^1)	(A)	(A'')	$(\frac{Y}{A})$	$(\frac{Y''}{A''})$	(W_t)	(W_s)		(R)	(S)

Sources

(a) Output, acreage and yield series are quoted from Bulletin of Agricultural Statistics of the Sudan, Ministry of Agriculture, Khartoum.

(b) Rainfall is reported in Internal Trade Statistics, Department of Statistics, Khartoum. (Arithmetical average of meteriological stations in Blue Nile Province.)

(c) Cotton prices and stocks are quoted from Internal Trade reports and I.C.A.C. Bulletin.

(d) Tenants' profit share in the Gezira scheme are quoted from S.G.B. annual statements of Accounts.

Table (12) — Data series used in estimates of production and yield of Sudan ELS cotton — Appendix (D)

	FERTILIZERS			INSECTICIDES			Management		
	Total Ann. Imports		Deflated actual costs incurred in Gezira scheme	Total Ann. Imports		Deflated actual costs incurred in Gezira scheme	Costs incurred in Gezira scheme (deflated)	Picking labour in Gezira scheme	Size of cotton tenancy in Gezira Fed./Tenant
	Volume (M. Tons)	Value deflated		Volume (M.T.)	Deflated value				
		LS (000's)			LS (000's)		LS (000's)	(000's) person	
1945/46	106	5.5		141	30.3			138.0	8.2
1946	2,761	117.7		226	25.0			138.6	8.5
1947	2,422	91.6		785	47.0			179.9	8.5
1948	3,504	106.4		451	41.8			188.6	8.4
1949	12,781	363.0		180	20.3			206.0	8.4
1950	10,363	266.0	311	205	26.9	186.0	409	203.7	8.4
1951	10,737	284.7	221	471	34.0	215	493	157.7	8.2
1952	24,589	638.9	355	218	28.5	220	477	203.4	8.0
1953	18,917	457.9	502	291	63.5	298	630	183.4	7.9
1954	18,810	328.2	319	239	41.6	179	484	205.7	8.5
1955	28,096	749.2	754	622	58.8	149	448	211.2	7.8
1956	23,126	666.6	594	790	96.3	101	400	251.9	8.1
1957	37,679	976.6	523	915	151.7	58	379	149.4	7.7
1958	37,699	1281.9	803	2,059	363.9	145	720	270.2	7.2
1959	34,160	1065.4	928	2,234	348.0	169	991	226.6	6.9
1960	50,193	1373.4	991	2,820	664.8	320	1,125	241.0	6.8
1961	68,841	1704.1	1,102	4,053	1232.9	721	1,219	396.6	6.7
1962	63,014	1294.3	1,103	5,013	1639.5	783	1,361	181.2*	6.6
1963/64	52,175	1326.1	1,191	2,983	1134.7	890	1,407	113.3*	6.5
	(F_q)	(F^1)	(F)	(I_q)	(I^1)	(I)	(M)	(L_p)	(Z)

Notes on variables and sources

(a) (F_q) and (I_q) are quoted from Sudan Foreign Trade Reports, Department of Statistics, Sudan. (F^1) and (I^1) are their respective deflated values.

(b) (F), (I) and (M) are deflated actual costs incurred as reported in the annual statements of accounts of Sudan Gezira Board.

(c) (L_p) is quoted from Sudan Gezira Board annual statements of accounts while (Z) is obtained from same source by dividing the acreage under cotton by the number of tenants as recorded every year.

(d) The discrepency between the figures of fertilizers (F^1 and F) and insecticides (I^1 and I) is due to the fact that Gezira figures include costs of application and spraying, costs are for crop year and calendar year as in the case of F^1 and I^1.

Table (12) cont/d..

Notes on variables and sources

(d) cont/d.. no adjustment for inventory figures and possibility of changing the classification which is most noticeable in (I^1) series.

* estimated.

Table (13) Costs of Cotton Production in the Gezira scheme* Appendix (D)

1953-1963

(000's Ls)

	All Costs (C 1)	Costs less expenses incurred on cotton seeds (C 2)
1953	4070	3370
1954	3765	3360
1955	3286	2938
1956	3921	3552
1957	4624 *	4159
1958	2866	2779
1959	4486	4016
1960	5167	4728
1961	4960	4697
1962	8559	7674
1963	7159	6696

* These are the items included in the Joint Collective Account of cotton production every crop year. Figures are taken from Sudan Gezira Board annual statements of accounts.

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