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COTTON MARKETING PROJECT

Feasibility Study

Annex 2 Pest Control

Annex 3 Ginning

Annex 4 Transport and Storage

SIR M MACDONALD & PARTNERS LIMITED
in association with
ASSOCIATED CONSULTANTS & PARTNERS
THE BRITISH COTTON GROWING ASSOCIATION LIMITED
HUNTING TECHNICAL SERVICES LIMITED
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PEAT, MARWICK, MITCHELL & COMPANY

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COTTON MARKETING PROJECT

FEASIBILITY STUDY

The Final Report comprises the following four volumes:

1. Main Report

2. Annex 1 - Inventory

3. Annex 2 - Pest Control
   Annex 3 - Ginning
   Annex 4 - Transport and Storage

4. Annex 5 - Grading and Testing
   Annex 6 - Telecommunications
   Annex 7 - Marketing, Organisation and Management
   Annex 8 - Financial and Economic Analysis

ANNEX 2

PEST CONTROL

ANNEX 2

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CHAPTER 1

INTRODUCTION

1.1 Background

The control of pests and diseases has always been a major factor in the successful production of cotton. The control measures which have been evolved in Sudan have generally been effective in controlling pests and diseases. In recent years, however, a serious problem has arisen from the incidence of honeydew or stickiness in seed cotton and lint as a result of whitefly infestations. The honeydew is causing Sudan medium staple (Acala) cotton to be discounted in world markets and is also causing a general loss of confidence in all Sudan cottons.

Although there was some reduction in the incidence of honeydew in 1981/82 with some continued reduction in 1982/83, towards the end of 1983 when prices firmed on the world market for cotton similar to Sudan Acala and there were indications of a shortage of this type of cotton, little interest was displayed by international merchants in Sudan medium staple cotton, and discounted prices for Sudan cotton continued to prevail. It would seem that the loss of confidence in the market in Sudan cotton as a result of honeydew contamination persists and is deep-seated. It is essential, therefore, for Sudan to tackle the problem of whitefly control with serious determination, exploring every possible method by which whitefly and honeydew can be reduced.

As the honeydew problem, if not controlled, is likely to have a major impact on future plans for production, handling, processing, grading and marketing, the Terms of Reference for this study call for a review of the status of pest control in general and whitefly/honeydew in particular.

1.2 Scope of Annex

This annex reviews the status of pest control and also gives a brief review of other diseases. The effect of pest control measures and honeydew on the various stages in the cotton marketing system will be covered in the appropriate technical annexes.

It is to be emphasised that the review of pest control is based on a one man month input from a pest control specialist/agronomist. In view of the limited time available the emphasis of the studies has been placed on the major problem of whitefly/honeydew control. Control of whitefly cannot, however, be considered as an isolated problem but only within the whole complex pest situation. This is a subject in which many scientists and field workers have been occupied for over forty years. It would be presumptive to hope, in the short study period, to do more than review the present situation regarding pest control, assess the possibilities for early reduction of honeydew contamination and indicate possible new approaches to the solution of this problem.

CHAPTER 2

HONEYDEW

2.1 Cause of Honeydew

Honeydew is the sugary secretions from the extra-floral nectaries of the cotton plant and from whitefly and aphids. The honeydew is deposited and accumulates on the leaves of the cotton plant and drops on to the open bolls and thus contaminates the seed cotton. The following sections describe the composition of honeydew and its production by the whitefly.

2.1.1 Origin and Composition of Honeydew

According to Ali and Khalifa (1980) the origin of the sugar deposits that are responsible for honeydew and the resultant stickiness in cotton is mainly the excretions of whitefly (Bemesia tabaci). Aphids (Aphis gossypii) rank second while plant exudates are unlikely to be directly responsible for cotton stickiness. Gas liquid chromatography analysis has revealed that both whitefly and aphid excretions consist of fructose, glucose and mannose. Whitefly excretions also contained two unidentified components named X and Y which were absent in aphid excretions.

Subsequent analytical work has confirmed that it is these components X and Y which are the direct cause of the stickiness that results in ginning and processing problems. Ali and Khalifa (1980) reported that the sugars isolated from both whitefly secretions and from sticky cotton were predominantly non-reducing sugars (oligosaccharides), in approximate ratios of 2 : 1 up to 4 : 1 to reducing sugars (monosaccharides), depending on infestation levels. The proportion of non-reducing sugars in contaminated lint is important when consideration is given to the possibilities of grading lint for assessment by potential buyers, whether or not the origin of such sugars is insect or extra-floral nectaries. Ali and Khalifa have proposed a system of grading based on total content of reducing sugars after hydrolysis comprising five grades.

2.1.2 Production of Honeydew by Whitefly

Both adult and juvenile stages of the whitefly feed by inserting the stylets into the plant phloem and taking up sap (Pollard 1955, Gameel 1968). Penetration of the epidermis is largely intercellular and the stylets' course through the parenchyma to the phloem may be direct or oblique depending on whether the insect is situated immediately below a vein. The stylets are extremely fine (1.5 to 3.0 microns), smooth and without barbs so that passage through the tissue is mainly between the cells. Feeding can only be done from the lower surface of the leaf since the distance from the upper surface to the phloem is too far (mean distance 138 microns as compared with 60 microns). The tissue is structurally undamaged during insertion of the stylets but feeding by the sedentary nymphs causes chlorotic spotting, the chloroplasts being destroyed by the saliva. The mechanics of the feeding process directly influence the efficiency of systemic and trans-laminar insecticides since for maximum effect these should move into and be transported through the phloem.

Sap is taken up by the insect and excreted as honeydew in enormous quantities. Gameel (1968) found in laboratory observations that the adults could produce 16 droplets (422 microns diameter) per hour so that a single adult could produce

sufficient excretion to cover 38 mm^2 leaf surface in one day. Early instars produced lesser quantities while the pupal stage gave higher levels. Progeny from a single female could produce enough to coat two average sized leaves. The excretion contains a high proportion of long-chain sugars which have been synthesised by digestive enzymes in the alimentary tract from simple sugars in the sap (Ripper 1965). It is deposited as fine transparent globules on the leaves, or lint of open bolls.

On drying the excretion changes first to viscous syrupy droplets and later to a dry powder invisible on the lint to the naked eye. The dry excretion is hygroscopic and absorbs water rapidly when the humidity rises causing the lint again to become sticky (Mound 1962, Gameel 1968).

2.2 Effects of Honeydew

2.2.1 Problems Associated with Honeydew

In the late 1950s intermittent reports were received of difficulty in processing Sudanese long staple lint in spinning mills due to the stickiness associated with the presence of honeydew. In the 1970s the numbers of complaints increased substantially, resulting in claims from end users via the marketing agencies and in rebates being paid. This has been accompanied by a decline in confidence in the quality of Sudanese cotton, which formerly was held in the highest regard. The problem has become particularly serious in the medium staple (Acala) cottons of which a substantial expansion in production has taken place.

Contamination is unevenly dispersed through the seed cotton and this together with its hygroscopic nature results in processing problems both at the ginnery and in the mill. With heavily contaminated cotton pre-ginning humidification results in hygroscopic uptake and stickiness of the seed cotton. The leathers of roller gins in particular become coated causing friction, and in extreme circumstances spontaneous ignition of lint has been reported. Choking of saws in saw gins occurs and causes fires. It becomes necesary to stop operations to remove the sugary deposit, resulting in delays and serious loss of production. Euroconsult (1982) quote a mean figure for time lost of only 0.8% total running time in five roller gin factories from the Marangan site of SGB. However Khalifa has estimated the reduction in output can reach 90% on a one day basis.

The honeydew contamination also causes serious operating problems in spinning mills particularly where the relative humidity in the mills is higher than 60%. To some extent the more modern mills with sophisticated air conditioning systems escape the major spinning problems by controlling humidity but on the other hand the more modern mills are increasingly using open ended spinning techniques which are more susceptible to honeydew/stickiness problems.

The problems of spinning mills are increased because the present system of classifying lint does not take account of honeydew contamination. Thus the spinner is not able to ascertain the degree of contamination before spinning.

If mechanical pickers are to be used contamination by honeydew would create operational difficulties for spindle picking machinery, and trash separation problems resulting from stripper-machined cotton.

2.2.2 Economic Losses due to Honeydew

The loss to Sudan as a result of honeydew is difficult to quantify. The losses result from claims on sales already made and a general downgrading of prices for all Sudanese cotton for the medium staple cotton and particularly for medium staple cotton from schemes with a poor reputation based on past honeydew problems.

Preliminary estimates show a reduction in the sale price of Acala compared with the Liverpool Index of around 15 cents/lb, which for 1980/81 on a 187 000 bale crop amounts to US$ 13 000 000 and for 1981/82 on 259 000 bales is US$ 16 000 000.

Although there has been less contamination of long staple cotton by honeydew there must inevitably be some effect on long staple prices and each 1 cent depreciation in price on an average production of 400 000 bales amounts to a loss of US$ 1 680 000.

In addition crop sales move slowly on a nervous market and stocks increase. The economic effect of honeydew contamination of Sudan cotton is therefore considerable and measures which would result in effective control of whitefly and reduction of honeydew would be of substantial economic benefit.

CHAPTER 3

WHITEFLY

3.1 Life Cycle

The whitefly (Bemesi tabaci Genn. Aleyrodidae) has been studied in depth by many workers and only a brief description is given here. The authoritative references include, Ripper and George (1965), Schmutterer (1969), Kranz et al (1977).

The adults are small, four-winged insects 1 to 1.5 mm long covered by a white waxy secretion (bloom) that protects the cuticle. The males are slightly smaller than the females. Reproduction is both bisexual and parthenogenetic. The active life of the male varies widely from around 15 to 25 days, and the female has been reported to live up to 61 days (Gameel 1974). An average of 160 eggs per female are laid.

The eggs are 0.2 to 0.3 mm long, pear shaped and anchored upright on the underside of a leaf. They are deposited in groups and Sippell and Omran (personnal communication, 1983), independently, state that eggs are preferentially grouped at the base of leaf hairs thus making the hairy leafed medium staple (Acala) cotton more susceptible. The eggs hatch after 6 to 9 days with optimum temperatures of 30 to 35°C. The period in the cooler winter is 8 to 12 days.

There are four nymphal instars. The first, or crawler, is mobile but soon settles to feed and becomes sedentary. The fourth instar, or pupa, ceases feeding and the reddish eye of the forming adult becomes visible. It is 0.6 to 0.8 mm long. The nymphal period is from 18 to 30 days dependent on temperature.

The egg/adult period ranges from 20 to 26 days in August/October under temperatures of 30 to 40°C down to 25 to 40 days in November/March. Thus 9 to 10 generations could develop during a cotton season, depending on temperature conditions.

3.2 Factors Affecting Whitefly Population

Infestation levels and hence the honeydew contamination varies widely from season to season. It is clear from examination of research and other reports dating from the early 1950s that not only have the population levels increased but also that the period of severe infestation now continues longer into the winter so that fields frequently carry high populations into March (Mound, Saunders et al). A number of reasons have been suggested for this but more work on population dynamics is necessary for a definite solution.

Research and experience indicate that increased levels of infestation are associated, among other things, with:-

(i) Early and heavy rainfall which results in abundant growth of alternative hosts from which migration takes place.

(ii) High nitrogen content in the leaf.

(iii) Early sowing of cotton (mid July/early August).

(iv) Levels and timing of nitrogen fertilisation.

(v) Cotton variety - whitefly favour hairyness

- early crop canopy closure provides shelter and increases the relative humidity within the crop.

(vi) Delayed onset of the winter season as expressed by cool northerly winds.

(vii) More intensive cropping.

These factors interact to determine whether a season is 'bad' for whitefly.

In general whitefly population build up is initiated by a primary infestion from outside the crop with secondary reinfestation occurring throughout the season from generations breeding within the crop.

The first primary infestation occurs in early September as adults move in from alternative host plants on which they have passed the hot dry April/June period, and on which 'pre-infestation' multiplication takes place coinciding with weed growth in fallow and crop residue (fodder) fields, vegetable gardens and along the canal banks and waste land, at the onset of the rains in late June/early July. The insect can live on a great number of alternative hosts (150 species in 31 families - Gameel 1972, Joyce 1959, Razoux Schultz 1960/61) including all the common annual weeds and some perennials, as well as many vegetable and other crops such as tomato, okra, lubia (Dolichos lab-lab), sweet potato, cucurbitae, beans, cruciferous vegetables, tobacco and cassava. Considerable numbers build up on these plants and in September, as the weeds seed and dry off, the whitefly migrate on to the cotton. Primary infestation waves can continue for many weeks from weeds growing in the groundnut and dura cultivated by tenants, and can be continual through to harvest in December.

The changes associated with more intensive cropping practices also have an effect. The old rotation included two or three years fallow in a 4-course rotation. In the newer Gezira rotation crops are grown three years in four while on Managil and Rahad there is no fallow break. The weed growth within these crops provides potential for pest build-up. Changed cultural practices have also affected the relationship between build-up and the amount and date of rains. Earlier workers emphasised that poor early rains increased nitrates available in the top 30 cm of the soil in the fallow, which in turn increased leaf nitrogen of cotton and hence caused a build-up of whitefly. In the absence of fallow the contrary now applied. Good rains augment early weed growth and urea application replaces the natural nitrate to provide ideal conditions for build-up.

Several workers in the 1955 to 1965 period reported that hairy-leaved jassid resistant cottons, both long-staple barbadenses and medium staple hirsutums, supported much larger populations of whitefly than similar glabrous-leaved varieties (Mound 1965, Evans 1965, 1962/63, Pollard and Saunders 1956, Proctor 1961/62). Saunders, 1965, went so far as to state that it was recognised that jassid resistance through addition of plant hair might never be acceptable in face of the whitefly problem. There is no doubt that introduction of hairy Acala varieties has been a major cause of the increase in the problem of control.

Secondary build-up is increased by the insect's short lifecycle and the longevity of the female. The 60 days over which egg-laying may continue results in continual adult emergence, masking cyclical generations. At the same time primary infestation from outside the fields will continue through to December. The whiteflies' requirement for shelter and humidity drives them into the lower canopy where they are largely protected from airsprayed insecticides which are unfortunately also largely ineffectual against its immature stages. The adult do, however, prefer to feed on the young growing leaves, i.e. at the top of the plant or branch extremities where they are more exposed to spraying. There is also a natural population decline associated with the onset of the cool winter.

3.3 Natural Enemies

Studies of parasites and predators of whitefly in the Gezira have been reported by Cowland (1939) and Gameel (1969). Four species are reported parasitic, Eretmocerus diversiciliatus Silv., Emundus Merc., Prospaltella lutes Masi (= Encarsia lutea Masi) and Prospaltella sp. Gameel also reported two predatory mites, Amblyseius aleyrodis El Badry and Typhlodromus sudanicus El Badry. The first was noted attacking eggs and first larval instars and the latter eggs and crawlers of the first instar.

Gameel reported total percentage parasitism increasing from 6% in August to 44% in December and then falling to a plateau at 30 to 32% from February to April. He considered these levels too low to give effective control of the pest. However, Sippell has reported levels of up to 90% in small scale field assessment (personal communication) and this is more encouraging when considered in the context of an integrated control programme.

3.4 Effect of Whitefly

Whitefly damage may be considered as:

(i) direct - resulting in yield reduction and

(ii) indirect - through honeydew contamination and loss of quality.

3.4.1 Direct Damage

From the mid 1950s it has been recognised that heavy whitefly infestations (Fowler 1956, Mound 1965) affect plant height, percentage leaf shed, numbers of picked bolls, bollweight, seed weight, yield, ginning outturn and lint index. It also may cause premature boll opening and grade reduction. Work from 1961 to 1964 (Prog. Rep. Exp. Stat. Sudan - CRC) demonstrated that high infestations caused a direct reduction in yield in both long staple and medium staple varieties. In both there appreared to be variation in varietal susceptibility. Large scale field spraying (6 000 feddans) confirmed a yield response to control with dimethoate or endrin in Bar XL1 cotton as against no control with DDT. That the level of infestation is correlated with incidence of damage has been demonstrated by Gameel (1967/68) in small scale cage tests. His results are shown in Table 3.1.

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TABLE 3.1

Effect of Whitefly on Yield

	Degree of infestation					
	V. Heavy	Heavy	Medium	Light	Nil	SE ±
Mean number of adults/leaf	72.7	36.0	16.8	6.0	-	
Mean number of 4th instar/ leaf	56.0	25.0	10.7	4.7	-	
Mean number of 1st instar/ leaf	273.9	133.0	59.0	24.3	-	
Plant height, cm	107	125	136	145	165	0.22
Bolls picked (6/12/19/67), Nr	20.0	27.8	27.9	29.1	41.2	2.53
Total yield, g	1 406	1 728	2 034	2 358	5 515	
Grade	6.4	6.1	5.9	5.5	5.3	0.11

This research has conclusively demonstrated that whitefly infestations reduce both yield levels and quality of lint as well as causing contamination by honeydew.

The yield reduction is thought to be due to the removal of nutrients from the plant resulting in a high carbon/nitrogen ratio. Plants having a low nitrogen content in relation to carbohydrate levels make poor vegetative growth without a compensatory increase in fruiting and in fact increased bud and boll shedding occurs. In addition, the removal of sugars by the insect results in poor lint development in bolls that do develop (Fowler 1956). High whitefly infestation is also associated with Gezira Wilt, apparently due to the inability of the plant to produce fine roots which in turn is thought to be due to lack of protein material (Joyce 1957).

Chloritic spotting of the leaves is symptomatic of nymphal infestation, due to destruction of chloroplasts, and in very high infestations the whole leaf becomes yellow.

3.4.2 Indirect Damage

The problems due to lint contamination are discussed in Section 2.2. Indirect damage is also caused by excessive secretion of sugars from the extra-floral nectaries which are stimulated by whitefly or aphid infestations, and by the growth of sooty moulds (Cladosporium spp.) on sticky leaves, which reduce photosynthetic and transpiration efficiency. There are no data on the precise effect of this.

CHAPTER 4

HONEYDEW REDUCTION BY WHITEFLY CONTROL

4.1 The Integrated Pest Control Approach

It has been suggested that the major reason for the serious build-up of whitefly was the failure of the 'pest control package deal' as carried out by the private sector. This is an oversimplification of the situation although there can be little doubt that resistance to certain groups of organo-phosphorus materials in the population result from repetitive application between 1972 and 1981 on very large areas of cotton. Failure to obtain control by spraying, whether through inadequate application techniques, ineffective insecticides, or insecticide resistance, is not the intrinsic cause of the population build-up but is due to reliance on a single strategy (chemical control) instead of utilisation of all possible means of control. Similar breakdowns are widely reported, notably in cotton in the USA, Central and South America where, in certain parts of some countries, total collapse of cotton production has only been avoided by the institution of the 'Integrated Pest Control Approach'.

The integrated pest control approach consists of the use of all possible control methods to reduce insect pest damage to a level that is economically acceptable. Integrated control includes the use of resistant or tolerant varieties, the manipulation of sowing dates, the adoption of agronomic practices that promote conditions adverse for the pests concerned (less verdant growth, a shorter cropping season), biological control - both natural and artificial (including the use of viruses, fungi and bacteria) and the fundamental practices of cotton sanitation, the close season. The concept accepts that the use of insecticides will be an integral part of any control system, provided that their use is as and when pest populations rise to levels requiring application despite other control measures.

In 1980 the FAO/UNEP expert committee on integrated pest control meeting at Wad Medani endorsed this approach in principle and preliminary results showing yield increases as compared with conventional insecticidal control were presented.

For a programme based on this concept to be successful the tenant farmer should not only be familiar with the basis for integrated pest control but should also actively participate in carrying it out.

The view that control of insects (and disease) is the sole responsibility of the scheme management authorities is obsolete and the Extension and Crop Protection Department should seek tenant involvement. Euroconsult (1982) has also emphasised the importance of restoring the tenants' motivation and participation in all aspects of production activity. The FAO/UNEP panel stressed the requirement and difficulties involved in obtaining tenant participation.

While control of whitefly to reduce honeydew contamination is the major consideration this can only be in the light of the whole pest control situation. The key pests which play the major role in influencing the pest control programme in Sudan are:-

Fleabeetles	-	Podagrica punticollis, P. pallida
Jassid	-	Empoasca lybica

American bollworm - Heliothis arinigera

Whitefly - Bemesia tabaci

Other potentially serious pests are pink bollworm, spiny bollworm, red bollworm, aphid, thrips and leafworm.

The effects of the pests other than whitefly are discussed in Chapter 6 and the various components of the integrated pest control approach are discussed in the sections which follow.

4.2 Development of Varietal Resistance

4.2.1 The Basis for Resistance

Niles (Maxwell & Jennings 1980), in his review of insect resistance in cotton, states that host plant resistance research with whitefly has been limited but that okra leaf provides resistance (Jones et al 1975), while high bud gossypol confers susceptibility to banded-wing whitefly (Trialeurodes abultilonea) (Lukefahr 1977). The association between hairyness and high whitefly populations has been widely reported (Section 3.2) and recent observations indicate that oviposition at the base of a hair may be beneficial, and is certainly preferred. Mound (1965) reported significantly higher numbers of eggs on hairy leaved varieties but was unable to correlate this with assessment of egg production by individual females caged on single leaves. He considered this lack was due to inadequate sampling at low populations and therefore concluded that hairyness simply provided more sheltered conditions. This requirement for shelter is further emphasised by the greater problems being encountered in medium staple (Acala) where a closed canopy forms earlier than in long staple (Barakat), negating the controlling effect of cool winds from November.

4.2.2 Developments

The on going breeding/experimental programme is encouraging and progress has reached an advanced stage towards the release of a commercially acceptable medium staple variety incorporating the four most important characteristics for resistance, namely:-

(i) Glabrousness

(ii) Okra leaf shape

(iii) Open plant shape

(iv) Earliness.

It is understood that this variety (Sudan K), on which work has been continuing for several years (Khalifa personal communication), is to be bulked on some 300 feddans in 1983/84. Quality of fibre is stated to be very satisfactory, and finer than Acala 4/42.

This development could be critically important for the solution of the honeydew problems, without which no other part of the integrated programme could be fully successful. Data on levels of whitefly populations in a range of resistant lines of medium staple varieties are given in Table 4.1 (Sippell 1983, summary of data to be published at a later date).

TABLE 4.1

Whitefly Populations in Resistant Medium Staple Cottons

	Line variety	Number adults/ 100 leaves	Number nymphs/ 100 cm^2
1	Barac type	2 425	337
2	-	541	207
3	-	512	110
4	-	991	324
5	Sudan K	476	106
6	-	405	123
7	-	63	68
8	-	513	57
9	Barac	931	51 [4]

Notes:
1. Date of count 7/12/82.
2. Mean of 3 replicates.
3. Cotton unsprayed throughout the season.
4. Nymph numbers in this count for line 9 showed marked reduction from earlier counts which were similar to variety Nr 1.

It is too early to know to what extent the potential for resistance will be manifest when field production over thousands of feddans eliminates bias due to choice, which is possible in small-scale trials. The combination of several characteristics for resistance makes for optimism however. An added complication is that the variety will lack jassid resistance and early season insecticidal control will probably prove necessary.

Other promising lines are being developed but these have not yet been adequately tested and release would not be possible for some years.

Realisation of the potential benefit of the resistant types will require reassessment of cultural practices such as spacing and plant population.

The upright open plant type could permit increased plant populations while still retaining a sufficiently open canopy to facilitate spray penetration and also aeration at the lower level to reduce both humidity and temperature. This combined with earliness might result in saving two or three spray applications (as reported from field scale trials) as well as an increase in the level of control obtained in the early season sprays. Assessment of these aspects should be accorded priority.

4.2.3 Other Possibilities for Resistance

(a) Tough Leaf

Saunders and Khalifa (Mound, Saunders et al 1964/65 to 1970/71) incorporated a 'tough leaf' characteristic into Sakel long staple cotton with a view to obtaining jassid resistance. Field screening showed it to be ineffective against jassid. It was not evaluated against whitefly at that time and the possibility of a thicker cuticle providing a physical barrier to feeding by whitefly deserves examination. This line of work is continuing, particularly as the material is also glabrous and carries blackarm resistance.

(b) Nectaryless

This characteristic is important for the resistance it confers against Heliothis spp., Pectinophora gossypiella (pink bollworm) and both jassid and lygus. There is no information on its potential against whitefly. However, reduction in the amounts of sugars secreted by the extra-floral nectaries would seem beneficial in any event and examination of this characteristic could well reveal some advantage.

(c) Bud-Gossypol

High bud-gossypol associated with increased density of pigment glands in cotton confers similar resistance to the nectaryless trait. The position with Bemesia is uncertain. Khalifa (personal communication) believes high gossypol may reduce palatibility but Lukefahr reported the contrary in banded-wing whitefly. It would seem this source of resistance should receive less priority in investigation than the other possibilities.

4.2.4 Work on G. barbadense

While the position of honeydew contamination is less severe in long staple cotton at present there should be no cause for complacency. The problem is there and should the integrated control package be as successful as is hoped in medium staple cotton the problem could become, relatively, more serious in the long staple.

An expansion of the host plant resistance programme is therefore recommended, possibly based on incorporating okra leaf and other characteristics into G. barbadense. The breeders at ARC are of course best able to plan such a programme. It is noted that formation of a special Cotton Research Fund as proposed in the Cotton Marketing Study (1981) has been accepted in principle. It would seem to be an appropriate fund source.

4.3 Biological Control

4.3.1 Beneficial Insects

On the basis of current knowledge the prospect for effective biological control does not seem promising. However, should Sippells's recent observations on higher levels of parasitism be confirmed the prospects would seem brighter.

Certainly the withdrawal of the wide spectrum insecticides DDT and, more recently, monocrotophos (Nuvacron, Azodrin and their mixtures) should allow the parasites and predators to multiply more effectively. Observations in commercial cotton at the end of the season should be done to clarify the situation. The possibility of mass rearing of Encarsia and Eretmocerus could be considered when further data are available.

It would also be advantageous if all insecticide screening work included an assessment of levels of parasitism of nymphs. Not only would this provide useful general data but would indicate those chemicals, or mixtures, that were destructive of beneficial insects, or conversely which appear particularly soft such as chlorfenvinphos (Birlane, Sapecron) and the pyrethroids.

It is appreciated that such study involves tedious and painstaking work in the laboratory by relatively senior staff but such effort should be rewarding in the long term.

4.3.2 Fungal Control

The use of fungal insecticides is receiving attention elsewhere, more particularly against aphid. The possibility for control of whitefly using one strain of Verticellium lecanii has, however, recently been noted (Hall 1982) and commercial development is being initiated. At present potential appears limited to use in glasshouses, but in the warm and relatively humid microclimate in the lower part of irrigated cotton plants conditions may be suitable for fungal growth. Testing of the commercially available product (Mycotal - Tate & Lyle, UK) should be considered.

4.4 Chemical Control

4.4.1 Present Situation

Chemical pest control in irrigated cotton in the Sudan is directed against Heliothis, whitefly, jassid and other pests.

In general control of Heliothis is reported to be very satisfactory and at present this is achieved with either endosulphan or one of the pyrethroids, decamethrin being most frequently applied.

Application is by air, either conventional hydraulic at 9.1 l/feddan (sometimes 13.6 l/feddan) or ultra low volume at 0.7 or 2.0 l/feddan. Commercial air spraying organisations are contracted for application on an annual tender basis. Tenders for both insecticides and spraying are issued by the SGB for all schemes. Precise recommendations, revised annually for insecticide use and application (dose rate, volume, swath width and number of runs per number (field), flying height, limitation by wind velocity and temperature, etc.), are set by SGB under ARC recommendation. Each individual aircraft is calibrated once at the beginning of the season (SGB Agric/2/-M-1 1981). The responsibility for selection of insecticide and time of application and supervision of field application rests with the field entomologists and scheme staff.

Table 4.2 gives the spray programme actually applied on the Gammus Group area of the Managil, which is considered almost the most serious whitefly area of the Gezira. This illustrates the insecticides now used, intervals, mode of application and rates of active ingredient recommended.

TABLE 4.2

Spraying Programme - Gammus 1982/83

Spray Nr	Interval (days)	Product	Volume
1	-	Endosulphan/Dimethoate	ULV
2	12	Decis/Dimethoate	ULV
3	17	Endosulphan/Dimethoate	ULV
		Kafil Super D	EC
		Endosulphan/Kafil	EC
4	10	Endosulphan/Dimethoate	ULV
		Endosulphan/Dimethoate	EC
		Endosulphan/Ekalux	EC
		Endosulphan/Kafil	EC
5	7	Endosulphan/Dimethoate	ULV
		Endosulphan/Dimethoate	EC
		Endosulphan/Ekalux	EC
6	7/8	Endosulphan/Dimethoate	EC
		Endosulphan/Kafil	EC
		Endosulphan/Ekalux	EC
7	7	Endosulphan/Mitac	EC
		Kafil/Mitac	EC
		Endosulphan/Ekalux	EC

Product and rate of active ingredient application (approximate)

		Active ingredient application rate (g/feddan)	
Endosulphan	at	370	
Dimethoate	at	180	
Decis	at	6.2	decamethrin
Kafil Super D	at	(1)	cypermethrin
Kafil	at	25	cypermethrin
Ekaflux	at	250	quinalphos
Mitac	at	400	amitraz

Note : (1) Data not known.

As recommended by ARC, seven sprays were given, the last two against whitefly alone. The first spray in mid September was against jassid with numbers 2 to 5 against the whole complex. Reduction in whitefly adults as assessed by pre- and post-spray counts (not detailed here) ranged from approximately 25% to 83%. Dimethoate mixtures tended to give poorer reductions than quinalphos or amitraz. The use of endosulphan mixtures, almost without exception, reflects the present opinion of both ARC and SGB that such mixtures enhance control of whitefly. This potentiation has not yet been substantiated by precise experimental work but opinion is overwhelming.

The Crop Protection Department of SGB reports that pest control in 1982/83 has shown an improvement over last year which, in turn, was better than 1980/81. Table 4.3, giving mean whitefly infestation levels over three years, would support this, but it must be considered indicative only.

TABLE 4.3

Trends in Whitefly Populations - Central Group SGB
Mean Monthly Number of Adults/100 Leaves

	September	October	December
1980/81	139	218	1 501
1981/82	39	177	1 121
1982/83	103	80	608

Unfortunately, November data were not available but it is apparent that, despite improvement, adequate control was not being achieved by December and this probably also applied to November. These data do not reflect the percentage reduction after spraying which might have been very satisfactory, but only the general population trend.

Reasons for the better control of whitefly achieved in 1982/873 were given as:

(i) Climatic conditions unfavourable for whitefly.

(ii) Better insecticide application due to proper aircraft calibration and better supervision in the field and at airstrips.

(iii) Wider use of newer more potent insecticides.

However, control was still not satisfactory and reasons given by SGB entromologists included:

(i) Lack of insecticides effective against nymphs.

(ii) Development of resistance to dimethoate and monocrotophos.

(iii) Application failure in that insecticide failed to penetrate the crop canopy to the target insect at time of peak infestation.

(iv) Shortage of field staff and communication/transport problems.

(v) Lack of equipment to measure wind speed and temperatures in the field.

(vi) Insufficient knowledge of population dynamics of whitefly and possibly inadequate application of accumulated knowledge. Scientists at ARC were in general agreement but, in addition, emphasised the changed environmental selective pressure due to increased cropping intensity and the increased fecundity of whitefly sprayed with DDT (prior to its withdrawal after the 1980/81 season) as major causes.

4.4.2 Insecticides

(a) General

Table 4.4 gives the range of insecticides used at present.

TABLE 4.4

SGB Insecticide Tender Awards for 1982/83 and Products Called For in 1983/84

Product			Quantities in Imperial gallons 1982/83	1983/84	Value C&F US$ 1982
Conventional					
Endosulphan	50	1	441 810	598 050	12 971 541
Endophos	16/32	2	203 535	227 870	6 673 913
Dimethoate	32	2	110 982	108 998	1 564 846
Bidrin	24	2	128 877	109 020	1 427 957
Mitac	20	2	181 530	105 370	4 505 575
Dursban	4	2	65 005	121 050	1 917 648
Ekalux	25	2	161 756	210 142	4 448 290
Ekatin	35	2	15 172	122 956	238 959
Curacron	400	1+2	1 584	5 310	69 633
Ripcord	40	1	-	3 600	-
Sumicidin	20	1	37 276	32 395	2 199 284
Decis	25	1	-	130 720	-
Kafil	S 25	1	-	7 605	-
Ultra Low Volume (ULV)					
Ripcord/Bidrin	1/9	1+2	6 666	98 340	73 650
Decis/Dim	35	1+2	229 260	262 275	3 175 251
End/Dim	50/20	1+2	79 280	82 895	2 846 152
Kafil Super	D	1	3 300	90 840	95 997
Dursban	23.9	2	65 005	121 050	53 280
Curacron	375	1+2	3 321	68 130	138 154
Soil Applied					
Temik	15	2	687 tonnes	1 321 tonnes	3 510 570
Total					45 910 709

Note : 1. Products principally for Heliothis control
2. Products principally for whitefly control

(b) Resistance

Initial findings from a three-year research programme (data presented by Dietrich at Wad Medani but not yet formally published) show that the present population, compared with an isolated Sudan strain, show resistance of the order of 300 x to dimethoate (consideration is being given to withdrawing or reducing the application of dimethoate in 1983/84) and monocrotophos, x 85 to quinalphos, but only x 9 to endosulphan. Resistance to other organo-phosphorus chemicals has also been demonstrated as well as cross-resistance to carbamates, although aldicarb remains highly effective. It is reported that three enzyme metabolic systems are involved.

Work at the Glasshouse Crops Research Institute, England on control of juveniles of other whitefly species showed these have a very high natural tolerance to nearly all insecticides (personal communication). This is in agreement with results at ARC (Gameel 1967/68).

With development of resistance the range of chemicals needed can be expected to widen, but consideration should be perhaps given to restricting use of some chemical groups, for example amitraz (Mitac), a chlorphenamidine, to alternate years in an effort to postpone onset of resistance. This approach has been successful in some countries (eg Zimbabwe with acaricides) but is complicated by development of cross-resistance, and the mechanism of resistance. It is worth recording that there is considerable lack of agreement among experts as to the best way to postpone resistance development, although all are agreed that fewer applications, thereby reducing selective pressure, is a basic criterion. Rotation of insecticides within and between seasons and the application of mixtures may, over a period of seasons, come to more or less the same result.

These facts make the prospects for discovery of any outstanding new foliar-applied insecticides doubtful, although some promising chemicals are close to release, such as chlorfenviphos (Birlane or Sapecron), while others are being evaluated at a more preliminary stage.

(c) Testing

At present testing of insecticides is based on control of adults as measured by initial knockdown and persistence (rate of population resurgence). In the early trial work reported by Gameel (1967/68 to 1971/72) control of nymphs was also assessed. It is recommended that this be reinstituted. The laboratory work involved is considerable but essential for a complete evaluation of potential, particularly in view of the rather inadequate results in the field now being obtained.

It is also suggested that reconsideration be given to testing and recommending products on the basis of active ingredient rather than commercial product, as is the case in many countries. This should reduce the work load and cost to ARC substantially. This would not necessarily apply to mixtures.

The use of a modified mini-log application system where one insecticide is applied at a constant rate and the second at incremental dose rates might be useful in clarifying the question of potentiation with endosulfan.

(d) Aerial Application Techniques

The specifications for aerial application issued by SGB are extremely detailed and are based on experience accumulated over many years as well as field testing by specialists such as the Desert Locust Control Organisation, Centre for Overseas Pest Research, Cranfield Institute of Technology, Aerial Application Research Unit, and also specialists from the private sector such as Ciba-Pilatus, Rousell Uclaf, Hoechst, Shell International and Plant Protection Ltd.

The Crop Protection Department of SGB has put special effort into supervision of application over the last two seasons and it does not seem likely that there is scope for much further improvement in technique. It is not considered that poor application is a significant cause of the whitefly problem.

A serious constraint is imposed by the fact that the closed crop canopy protects the target insect. Penetration of spray within the lower two thirds of the canopy is due to gravity with deposit onto the upper surface of the leaf only, as there is practically no air movement low in the canopy to carry insecticide to the undersides (Courshee 1982).

The denser the foliage the lower the proportion of spray reaching the lower two thirds of the canopy. This applies to both ULV and conventional application but it should be noted that the range of size of droplets produced by boom and nozzle equipment is much greater than ULV, with a far greater proportion of spray lost through drift of the small droplets.

This loss is further increased by evaporation under the high temperatures and it is to be expected that ULV spraying would give better results throughout the season than conventional.

Spraying, whether ULV or conventional, should preferably be cross-wind since the slight downwind dispersal of the spray creates an overlapping effect. It also makes for greater pilot safety. The layout of the cotton 'numbers' is such, however, that this is not always possible.

The spraying flight path is always along the length of the 1.35 km long cotton number and the number of swaths depends on the calibrated swath width for each particular aircraft, the pilot counting the number of runs with a check made from the ground. Calibration of aircraft is carried out for spraying with the wind but it seems probable that 'stripey' application with lower deposit between swaths will inevitably occur particularly in the absence of flagmen to guide the pilots.

Flagmen have been used in the past but are no longer used because, it is understood, of organisational difficulties. It is considered that an effort should be made to reintroduce flagmen perhaps by involving the farmers in this activity. The use of permanent colour coded flags has not been successful because of the problem of theft.

When temperatures and wind speed rise above certain defined limits the field entomologist should halt spraying. Since they have no instruments recording these parameters spraying is simply suspended between 10.30 and 15.00 hours approximately. This is not satisfactory especially as temperatures greatly influence efficiency. It is recommended that each airstrip be equipped with the necessary instruments.

Communication between the field entomologist and airstrip at present depends on vehicle and fuel availability and at times is reported to present problems. It is recommended that the possibility of establishing radio communications between the field entomologist and the airstrip be examined, in the light of the overall scheme telecommunications requirements, and existing and planned developments. Precise specifications are given for micronaire atomiser settings and in-flight operation. These should produce the optimum droplet size conditions at calibration, early in September.

However, this cannot take account of changed climatic and crop growth conditions in November and December. It is possible for micronaire settings to be adjusted to optimise droplet size according to field conditions. Micronaire blade setting is simple and it is suggested that work on calibration and droplet deposit under a range of conditions should be initiated to see whether recommendations for simple adjustments in the field could be given.

Introduction of the new open okra-leaf variety would mean that all aircraft should be recalibrated for use on this different type of cotton, in order to obtain maximum benefit.

Some of the spray contractors are thought to be relatively inexperienced and it is probable that many pilots may not have sufficient appreciation of the technological basis for application, particularly for ULV application. The consultants suggest that consideration be given by the SGB - as co-ordinators of the air spraying programme to

(i) arranging pilot refresher courses in Sudan to be given by a suitable internationally recognised organisation such as the International Centre for Application of Pesticides,

(ii) inclusion in the tender of a clause requiring attendance by a senior pilot on such a course overseas.

(e) Scouting and Action Thresholds

Timing of application is determined by pest scouting. Action thresholds utilised are :

Flea beetle	20 adults/100 leaves
Jassid	50 nymphs/100 leaves
Whitefly	200 adults/100 leaves
Heliothis	10 larva/eggs per 100 plants

A measure of discretion is permissible to the field entomologists depending on area, crop growth, crop stage and other factors which could determine the return on spraying. Ideally the timing of spraying should be based on an 'economic threshold' based on a knowledge of that population of a particular pest which will result in an economically unacceptable loss in yield or quality if not controlled.

The complexity in determining economic thresholds may be illustrated by noting some of the variables that have been taken into account by Sterling & Lincoln (1977).

Among them are :

(1) Variation of climate and its effect on the development of the cotton plant and pest populations

(2) Cotton variety

(3) Economic factors that may fluctuate annually :

Sale price of cotton
Cost of application of insecticides
Cost of alternative control measures
Other production costs

(4) Cropping practices.

(5) Consideration of measures to delay onset of insecticide resistance in the pest population.

(6) Influence of insecticide spraying on potential biological control organisms and on potential secondary pest development.

(7) Variation in potential yield associated with variable soil fertility.

(8) Fluctuation of whitefly adult populations and their movement between crops.

(9) Spatial distribution of nymphs and adults on the plant related to growth stage, i.e. which part of the plant is chosen for sampling, and to non-random oviposition related to factors such as temperature, humidity and shelter requirements

(10) The relationship between boll-loss and quality reduction caused by whitefly and other pests and disease

(11) The efficiency of the sampling system. If this is inadequate the whole concept collapses since data on population are unreliable.

With the present level of knowledge the possibility of setting realistic economic thresholds for whitefly is slight, but this should be a major research objective.

Until this is achieved it may be advisable to review the action levels which are currently recommended and consider whether these are satisfactory in the light of experience and experimental results acquired during the last decade.

The timing of the first pesticide treatment is normally dependent on counts of fleabeetle, jassid and Heliothis. The longer this is delayed the greater the chance of effective control by beneficial insects, particularly against whitefly. In 1982 first sprays in some areas were delayed (due to shortfall in insecticide rather than low pest numbers) and it has been suggested this

contributed directly to better season-long control of whitefly. It would require analysis of field scouting records and season-long spraying schedules throughout the whitefly areas in order to compare results in early and late sprayed areas to verify this. It is recommended this should be done on the Gezira, and results linked to yield and quality of the crop. Should it be confirmed that beneficial results were obtained by delayed spraying in areas where Heliothis and jassid were not sprayed for until well above the current action thresholds then there would be clear grounds for revising early season action thresholds. Appendix 1 gives details of action thresholds for Heliothis in other countries for comparison with that adopted in Sudan.

Scouting to ascertain whitefly populations presents difficult problems. Counts of sedentary nymphs is impractical in the field since they cannot be counted with the naked eye. The adults on the other hand fly when disturbed particularly when temperatures rise. This can lead to great variation as shown when duplicate counts are made in the field. This may be important in the early stage of build-up, as spraying may be carried out too late. One solution suggested is that additional leaf samples should be taken in all counts in September and nymphal counts be made at Group entomology offices. Inexpensive X 10 magnification dissecting microscopes should be provided for this. ARC should establish an early season nymph population threshold level, related to adult populations. This would, of course, only indicate potential secondary infestation build-up. Primary infestation can only be assessed by adult counts.

An alternative method of scouting that should be investigated is the use of sticky yellow plate traps to which whitefly are naturally attracted. These could be placed at two levels in the cotton with counts made weekly. This method is used successfully in Israel (Melamed-Madjar, Cohen et al 1982), where Cotnion (azinphos-methyl) is used at 2.5 l per ha when weekly trap catches reach 100 to 200 adults per trap (Melamed-Madjar 1982) and good control of adults, nymphs and honeydew contamination has been recorded. Their control strategy is to hit early season infestations to prevent population build-up, but they accept the necessity for late season control to reduce contamination.

(f) Ground Application

The problem of penetration of insecticides could be solved by use of either high-clearance self-propelled sprayers with the droplegs fitted with upward facing nozzles, or more cheaply by knapsack-sprayers equipped with the Gatooma tail booms. The former can be designed for either ULV insecticide application, or for conventional use. The use of such sprayers does, however, present considerable practical difficulties. The irrigation schedule prevents field entry for spraying for perhaps 50% of the time. Furthermore the rotation of irrigation water between the nine farmers of a cotton number would preclude spraying of a complete number at any one time. The cost of equipment and logistic problems of supervising mixing of toxic chemicals, and supplying clean water, over great areas of irrigated cotton are all drawbacks. However, the potential benefits from increased whitefly control are such that very serious consideration should be given to its possibilities and it is suggested that a pilot area of perhaps 10 000 feddans be converted to ground application (after crop canopy closure), preferably in an area where there are many problems of air-spraying (close to villages or group centres, or having many pylons and electric cable, etc.). Early season routine air-spraying would be carried out. It should also be noted that in a commercial field scale trial last season excellent results were obtained with high clearance tractor application, and yield increases of the order of 3 kantars/feddan were obtained depending on the

chemicals used. The medium staple (Acala) cotton was stated to be clean of whitefly until mid-January, with possibly two fewer applications made. It was roughly estimated that the total capital cost of the tractors would be repaid in the first year from the saving on insecticide application plus the indirect saving due to reduction in honeydew contamination. This would require confirmation since equipment costs, and output per machine, might be very different if ground spraying is adopted on a large scale.

The use of knapsacks is more practical, but the logistical problems of providing small packs of chemicals and accurate measurement, of water supply, of labour, of maintaining equipment in proper working order, and also the hazard of toxicity with several of the chemicals, would be considerable for large-scale application.

(g) Soil-Applied Insecticides

Trials since 1968 (Gameel) have confirmed that very good control of whitefly, assessed by both adult and juvenile counts, is obtained by use of aldicarb at 1.2 kg active ingredient/feddan (7.7 kg Temik 15 G). Unfortunately no other soil-applied systemics have given useful control (e.g. phorate, carbofuran). In 1982/83 Temik was used on about 45 000 feddans of cotton, applied about six weeks after sowing and was reported to give excellent control for six to seven weeks, both of adults and nymphs. The manufacturers have supplied the necessary application equipment as part of a package. It was stated that 200 000 feddans would be treated in 1983/84.

On this basis control will be obtained through to late October/early November depending on planting date, and thus results in terms of reduced honeydew contamination depend on whether the subsequent whitefly build-up in November/December can be suppressed by aerial application. Experience so far is positive. Reduced nymph populations through to January 15th have been reported in trials (Omran, personal communication).

There are three drawbacks to extensive use of aldicarb.

(i) Extreme toxicity hazard

(ii) Cost

(ii) Application problems

The cost depends on how many additional airsprays are needed for early season control of jassid and Heliothis, and for supplementary late season control. The manufacturers believe three additional sprays are necessary using endosulphan or pyrethroid plus a systemic against whitefly. An approximate comparison is given in Table 4.5, based on a field trial in 1982/83.

The insecticides used for the extra four standard sprays will determine the actual difference and in this case three expensive chemicals were included. The increased cost would be acceptable if results are good. Application of Temik at six weeks presents no problem.

TABLE 4.5

Comparison of Temik and Standard Control Programmes (LS per feddan)

	Temik	Standard
Temik at 7.7 kg/feddan	58.8	
Cost of application	3.5	
Standard insecticides x 3 →	18.8 x 7 →	59.2
Cost of application	9.0	21.0
Total	90.1	80.2

Best results are reported from double treatment with Temik (Gameel 1968; personal communication), but the second application required in November presents a problem due to the extensive plant cover. The only practical solution would be with high clearance tractors equipped with droplegs and trailing hoses and a metered, pressurised distribution system, but this would involve extra capital cost.

The toxicity hazard is considerable, possibly more due to storage and spillage during application than to contamination of field workers. Fields treated should be monitored to check whether higher than average sickness occurs in the tenants' families and hired labour. This should be the responsibility of the Group entomologists. ARC has rightly emphasised the toxicity hazards, especially in connection with a large-scale operation. Higher rates and later planting may increase the level of residues in cotton seeds, a highly important by-product. The maximum residue allowed in cotton seed was set at 0.1 ppm by FAO/WHO in 1979. It has been reported that analyses of residues in sample seed carried out in 1982 showed disturbingly high levels. This somewhat unexpected finding should be reconfirmed by further analysis of seed samples from the 1982/83 season, with adequate numbers of control samples from untreated fields.

Despite the high cost and toxicity hazard it is considered that large-scale use of aldicarb is warranted in view of the serious whitefly problem at present existing in the southern part of Gezira and Rahad, particularly in view of it being the only insecticide demonstrably effective against juvenile stages. It must be emphasised, however, that close monitoring of the toxicity hazard must be carried out.

4.5 Cultural Control

4.5.1 General

Much research has been carried out in the Gezira on the influence of climatic factors, date of sowing, nitrogen fertilisation, irrigation, disease (leaf curl and bacterial blight), plant populations and spacing, pest incidence and spraying for pest control, and their interactions, on the growth and yield of cotton.

Earlier work concentrated on long staple cottons and there is relatively little published work on the medium staple (Acala) type, although this type has also been widely researched by ARC (Burhan & Taha 1974, Burhan & Jackson 1969 and other authors referred to). It is not intended to review these results and the major factors contributing to build-up of whitefly populations have been given in Section 3.2. The major factors influencing cultural control of whitefly and other pests are given in the following section. Cultural measures which will control honeydew contamination (early picking) are discussed in Chapter 5.

4.5.2 Sowing Date

It has been demonstrated that early sowing (July 20 to August 10) combined with post-planting nitrogen application and thinning to an even stand results in increased yields of the present varieties of both medium and long staple cottons but only with disease-resistant varieties and where pest control is effective. The major pests - flea beetle, thrips, Heliothis, jassid and whitefly are all potentially more damaging on early cotton. Under present conditions good control of all these pests except whitefly is being obtained.

The option to revert to late planting as practised before blackarm-resistant varieties were developed exists but this could only be advocated if all other means to control whitefly fail, and results would at any rate be open to doubt due to the greater hazard of primary infestation associated with the higher cropping intensity now practised. The alternative would appear to be development of earliness in the cotton plant, whereby later sown cotton would 'escape' attack but reach maturity by November. This has reportedly been achieved by Khalifa in Shambat B and Sudan-K varieties.

4.5.3 Nitrogen Fertilisation

The value of nitrogen application in the face of whitefly infestation must be questioned. High leaf nitrogen is conducive to whitefly build-up, and hence use of urea fertilisation will result in increased populations without any yield increase unless whitefly is controlled. The economics of use of urea is therefore open to question where control of whitefly is not obtained.

From the above consideration it is evident that the potential benefit from early sowing and urea application is not being realised and the farmers' margin of return is reduced. Consideration should therefore be given to a review of the recommendation for urea fertilisation of the present medium staple (Acala) varieties, as a short-term measure, within the general integrated pest control package.

4.5.4 Other Cultural Control Measures

These include basic agricultural practices, such as land preparation to obtain uniform stands, thinning, avoidance of late gapping up, effective weed control both in fallow and cultivated fields, an understanding that requirements for varieties may vary and that those for medium staple may be different from those for long staple cotton.

The policy that medium staple is concentrated in the southern growing areas such as Rahad and south Gezira must, in retrospect, be questionable. The colder climate and lack of natural vegetation in more northern areas could have favoured whitefly control. It is, however, impractical to consider changing this policy now.

Total segregation of medium staple cottons from long staple and other varieties which implies the withdrawal of medium staple from the Gezira has been suggested since it is apparent that honeydew contamination is becoming increasingly important in long staple, and it is clear that whitefly moves from late season medium staple into long staple, although the onset of cold winter winds should curtail this movement. It must be remembered, however, that introduction of hairyness into long staple varieties enhanced its attraction for whitefly and increased infestation would have occurred even in the absence of medium staple. Furthermore the movement of whitefly by wind over quite long distances as postulated by Joyce (1975) makes it probable that to be effective segregation would have to be by possibly one or more hundred kilometres. It is considered, therefore, that it would not be practical to totally isolate the two types of cotton, and it is doubtful whether it would now be acceptable to the farmers. Finally it is hoped that implementation of the integrated pest control package and new varieties will make total segregation unnecessary.

CHAPTER 5

HONEYDEW CONTROL THROUGH FARMING SYSTEMS

5.1 Introduction

The major contribution to honeydew control must come through timely picking and crop termination. Without a new approach to picking the potential benefits from measures to control whitefly and honeydew will not be realised. The reasons for extended picking are :

(i) labour shortage especially at time of groundnut and dura harvest;

(ii) desire to pick the maximum number of bolls associated with the greater rate of picking of the first and second pick and hence lower costs;

(iii) the requirement for livestock feed in dry season;

(iv) treatment of medium staple, short season Acala in the same way as long staple.

5.2 Irrigation Water Cut-off

Timely application of irrigation to avoid water stress is important for optimum yield and to permit realisation of potential yield increase from nitrogen fertilisation, good weed control and other improved practices. It should also facilitate movement of systemic insecticides within the plant and enhance pest control.

The acceptance by the tenant farmer of water cut-off is more controversial. This is especially important in medium staple types where boll opening commences in November and picking should be well underway in December and completed in January. Water cut-off at the appropriate time would speed maturation and onset of senescence, as well as opening the crop to the controlling influence of wind, temperature and reduced humidity. It would also help in obtaining better control of weeds and fodder crops in the main cotton growing areas. For medium staple cotton, cut-off would be about the end of November, although this would depend on planting dates and plant maturity. Extension of the crop period results in little yield increase and provides a potent reservoir for continued infestation of the long staple crop. Early picking would not only dramatically cut the incidence of honeydew contamination but should also bring an overall improvement in grade.

Similar considerations apply to long staple cotton.

It is appreciated that reasons for extension of the crop by the tenants include not only the desire to maximise yield but also a requirement for cattle feed and competition for labour to harvest groundnuts and dura. The question of alternative sources of fodder and the impact of livestock development in the Gezira (and other schemes) cannot be considered here. However, an effective solution to the whitefly/honeydew problem will depend on acceptance of early picking and termination of the cotton crop, and for this to be acceptable to the tenant farmers alternative fodder would need to be available for their cattle.

5.3 Crop Termination Chemicals

Work in Sudan on cotton defoliation has been oriented towards use with mechanical pickers. Some work has additionally been done on their potential for defoliation for reduction of honeydew contamination by eradication of the food source. This has been partially successful but with both desiccants and defoliants the sticky leaves adhere to the lint when falling to the ground. In fact some reports were that the additional sticky trash very seriously reduced quality.

The possibility for use of chemicals to aid harvest by hand do, however, warrant closer investigation, particularly in the expectation that whitefly levels will be controlled into December. This might permit use of defoliants without increased contamination. Additional advantages could derive from more rapid picking in the absence of leaves (threefold increase in productivity possible) and accelerated boll opening which is associated with the use of desiccants. A further point is that if cleaning equipment is installed in the ginneries, as is proposed, the importance of trash will be substantially reduced (this in itself may permit more rapid picking and greater realisation of the potential from defoliation).

Defoliation would not be beneficial if fresh leaf is produced to the extent that contamination is resumed before picking. Timely irrigation water cut-off would obviate this possibility but consideration should also be given to use of crop-termination agents to extend the period of senescence or to kill the crop entirely.

A further possibility that would be worth investigating is the use of defoliant much earlier in the season to eliminate some of the lower canopy foliage.

It is reported that this has been promising for control of boll-rot in Central America. Low doses of Folex have been applied before boll opening with a follow-up spray later so that the lower canopy is opened up, facilitating aeration. This would require detailed investigation and very careful timing.

It is emphasised that use of defoliants requires acceptance of a crop-termination date and water cut-off by the tenant farmer. Effort should be concentrated on obtaining maximum early season crop and sacrificing the few late season bolls on which the farmer appears to place undue value.

5.4 Timely Picking

Unless inducement is offered to the farmer it is unlikely that he will change his present approach to cotton harvesting. This inducement should be such that both the farmer and hired worker stand to benefit, while the state producing and marketing organisations derive benefit through maintenance of grades and reduced honeydew contamination by selective picking.

The present system provides the tenant with incremental payment according to grade, but no account is taken of honeydew since degree of contamination cannot be accurately assessed at the collecting stations. It is suggested that this system can be greatly improved by the simple expedient of paying an additional bonus for picking by a certain date, in part dependent on date of sowing. Thus Acala cotton sown before July 31st would attract a premium if picked and delivered before, say, 15th December. A sliding scale could be set for deliveries later in the season. The premium would simply be additional to the

standard grade-related prices. The premium would have to be sufficiently attractive to the farmer to encourage early planting and picking, and enable him to pay hired labour increased rates for picking cotton. The amount of premium should be announced in advance of the planting of the crop, although the qualifying delivery dates would have to be determined in the light of circumstances during the season. An example of a bonus payment is given in Chapter 7.

Mechanical picking would enable harvesting to commence earlier following the application of defoliants, crop termination and water cut-off, less labour being required. However, as long as labour is available it is not desirable to introduce mechanical picking and particularly not for long staple varieties, the high quality of Sudanese cotton being dependent on hand picking.

Labour difficulties result partly from the requirement for groundnut harvesting which can be mechanised more easily than cotton picking. Groundnut harvesters have been used successfully in the Rahad Scheme and an extension of their use elsewhere warrants examination.

5.5 Spatial Segregation

In the past entomologists have tried to indicate honeydew contaminated and non-contaminated cotton by marking bags at the collection centres according to field assessment, and by asking tenants to pick cotton on field margins separately. This is understood to have caused farmers to feel their grades would be penalised for honeydew, control of which is officially management responsibility.

It is reported that the whitefly move southward in the cotton numbers to seek maximum shelter from the cool northerly wind, and that honeydew contamination is worse at the southerly end of a number. If detailed field studies confirm this, then it may be possible to segregate the cotton at the collection centre based on the location of the farmer's holding in relation to the prevailing wind direction. The administrative difficulties in adopting such a system would, however, probably be considerable.

It is known for a particular scheme, for a particular year, that certain areas are more problematic for whitefly and honeydew control than others. Those collection centres from which contaminated cotton is likely to originate can be identified. It is recommended, therefore, that at the least there should be separation at the ginnery of cotton from each collection centre. The collection centres could be classified by degree of honeydew contamination and the cotton ginned accordingly. The 300 bale lots could then be produced from cotton from a single collection centre or from collection centres with a similar degree of contamination. This system would be simple to administer and would provide the opportunity to isolate contaminated cotton, which at present may be randomly distributed thus causing a general lowering of standards.

CHAPTER 6

OTHER PESTS AND DISEASES

6.1 Other Pests

The other major pests recorded from the Sudan that could have a serious effect are pink bollworm (Pectinophora gossypiella), Sudan bollworm (Diparopsis watersi) and cotton stainer (Dysdercus spp.). The first is reported throughout the country but is only occasionally important in raingrown cotton. The Sudan bollworm is seldom seen now in the central irrigated area but can be serious in Gedaref, the Gash delta and in raingrown cotton. Stainers have a similar distribution.

The two bollworm species cause both loss and quality reduction in bolls in which they pass much of their larval period. The stainers cause considerable quality reduction through introduction of spores of the fungus Nematospora gossypii, particularly in young bolls attacked from 5 to 7 weeks after bollset.

Only in the raingrown, short staple Albar type cottons is there likely to be any important adverse effect on lint quality due to the above pests. This should generally be controlled by routine spray with carbaryl against all three pests.

No effect from boll rots due to direct fungal infection is likely on any Sudan cotton, since none is produced under the excessively humid and rainy conditions required for these fungal diseases.

6.2 Bacterial Blight

The position regarding blackarm disease (bacterial blight) Xanthomonas malvacearum gives cause for considerable concern. For the past few seasons reports of increasing incidence of the disease have been received from the field. It is believed this is due to evolution of a new strain or strains which is reputed to be tolerant to (or able to circumvent) all natural resistance conferred by incorporation of the range of B genes for heritable resistance on the present varieties of both medium and long-staple types of cotton.

The alternative reason postulated, that seed of the cotton varieties is no longer true to type, i.e. that susceptible material has inadvertently been introduced, has been considered but would appear unlikely if all cotton varieties currently grown show a similar degree of disease incidence. This has not been ascertained and a specific survey should be conducted to confirm the laboratory work on susceptibility of material collected in field which is now underway at ARC (Omer, personal communication).

On the basis of present knowledge it is not possible to comment further than that the position gives cause for concern and record that ARC is following two lines of research to solve the problem.

(i) Long-term: survey of potential new sources of resistant germplasm and subsequent transfer and breeding of new varieties.

(ii) Short-term: assessment of possibility for 'horizontal resistance', i.e. incorporation of different forms of resistance which cumulatively confer higher resistance than single line genetic resistance.

It is, however, necessary to consider the effects of a major breakdown of resistance. One immediate effect of this might be a necessity to revert to late-season planting (mid August/September) to escape infection associated with the rains (Jackson 1969, Andrews 1936, Jackson, Faulkner and Razoux 1967). This would have extremely serious effects on production, particularly of medium staple since delayed planting would mean that temperatures would drop at precisely the time when high temperatures are necessary for good growth and optimum boll development. Yield levels and grade of both long and medium staple cottons would be adversely affected. An indirect effect of late planting would be amelioration of the whitefly control problem. An important preventative control measure that should be emphasised to the farmers is the requirement for total destruction of cotton residues by uprooting and burning as early as possible and before April 30th at the latest. (This again raises the issue of integration of livestock fodder into the cropping pattern.)

The implications from resurgence of bacterial blight are fully appreciated by ARC and priority is being accorded to work on the problem.

CHAPTER 7

SUMMARY AND IMPLEMENTATION OF HONEYDEW CONTROL MEASURES

7.1 Summary of Control Measures

The most important pest control measures particularly for whitefly and for reduction of honeydew can be summarised as follows :

(i) Better cultural controls, including earlier irrigation water cut-off.

(ii) Earlier and timely picking.

(iii) Improved pesticide application technology and supervision.

(iv) More potent foliar applied chemicals.

(v) Suppression of whitefly with soil applied aldicarb principally against juvenile stages.

(vi) Use of harvest aid chemicals.

(vii) Segregation of contaminated cotton through controlled crop delivery.

(viii) Development of resistant varieties, and those producing less foliage and less leaf hairiness.

The impact of these measures on the control of whitefly and the improvement of crop quality and yields depends on how well and how quickly they can be implemented. The separate measures confer benefit individually but it is their combined and cumulative effect that will result in most improvement and lasting control. The effects of the measures can conveniently be categorised as short, medium and long term.

7.1.1 Short Term Effects (up to 1985)

In the short term it is possible to envisage a useful impact being made by (iii) and (v). Of these, the use of aldicarb, supported by foliar insecticides, is likely to have the greater impact. However in the absence of (i) and (ii) the consultants do not expect a marked reduction in honeydew contamination.

7.1.2 Medium Term Effects (1985 to 1990)

The impact from probably the most important measure, the introduction of Sudac-K, depends on the rate at which it can be introduced. Multiplication from a 300 feddan block to, say, 500 000 feddans requires at least four seasons, even assuming that no complications occur. Thus by 1986/87 its impact could be substantial, permitting (iv), (v), (vii) and (viii) to have a greater impact in turn.

At the same time there should be a steadily increasing effect from the introduction of timely picking and the segregation of contaminated cotton. These two measures should start to have a substantial impact from 1985 onward.

The impact of the use of harvest aid chemicals is difficult to foresee, depending as this does on research as well as integration with (ii) and (vii). However, assuming reasonable success the contribution could be effective by 1987.

7.1.3 Long Term Effects (after 1990)

Assessment of the long term effects of the whole integrated control programme depends in part on complex issues posed by the development of livestock within the irrigated schemes and thus fundamental changes in the farming systems which are outside the scope of this report. Also involved are the possible resurgence of jassid as a difficult pest, the influence of Heliothis and the possible re-emergence of bacterial blight as the major limiting factor. The consultants are however confident that the way is open for containment of the honeydew problem, provided that implementation of the integrated control programme is pushed ahead.

7.2 Implementation of Control Measures

The reduction in the value of cotton lint due to honeydew contamination of up to US cents 15 per lb on medium staple cotton (equivalent to some US $ 30 million on 500 000 bales), and the added financial drain of carrying increasingly large slow moving stocks, justifies expenditure on a major programme for whitefly control and also supports the introduction of inducement payments to farmers and producing corporations. It is recommended that during 1984 a crash programme should be initiated, based on the control measures listed above. While medium staple cotton should be the main target of the programme, as it is Acala cotton which is suffering from the highest contamination, it is also necessary to consider the effect of whitefly on long staple varieties and to maintain controls on whitefly infestations.

Detailed formulation and co-ordination of the programme should preferably be undertaken by the new Sudan Cotton Board (see Annex 7). It is envisaged that the main features of the programme would be as follows :

(i) Research and Extension Services

A key element of the crash programme would be the strengthening of the research activities of the ARC with regard to honeydew and of the extension link between the ARC and production units. This would involve :

- Provision of technical assistance to reinforce the cotton research team at Wad Medani and to assist in extending recommendations through the extension services in the field to the farmers. A specialist agronomist and an entomologist, both preferably with previous experience of Sudanese conditions and irrigation regimes related to cotton production, should be provided for a period of at least two years, or three cotton seasons.

- Recruitment of additional Sudanese personnel for cotton research.

- Provision of additional vehicles for the cotton research unit to improve mobility and strengthen the integration of the work of the research team with that of the extension services in the field.

- Construction of an extension to the Cotton Research Unit laboratory building at Wad Medani to accommodate honeydew testing equipment.

- Assistance to producing corporations' extension staff in the form of transport and additional personnel to facilitate communications, programme planning and meetings with farmers to explain the problems and the procedures to be adopted.

Implementation of these measures largely falls outside the scope of the Cotton Marketing Project itself. In the case of Gezira, and the Cotton Research Unit, it is likely that some funding will be available under the Gezira Rehabilitation Project. It is, however, proposed to include under the Cotton Marketing Project the extension to the laboratory at Wad Medani (see Annex 5).

(ii) Research Priorities

Research under the crash programme should concentrate particularly on the following aspects :

- Further research concerning plant spacings and populations, leaf canopy and ground cover, penetration of aerial spraying, etc. Currently there is a breeding programme in progress at the Cotton Research Centre directed towards reducing plant leafage and leaf area, and also towards producing an okra type of leaf shape, in order to reduce the leaf area required by massive whitefly populations.

- An investigation into current insecticidal control procedures and applications with the object of improving effectiveness. The investigation should include an assessment of the effectiveness of various foliar applied chemicals, ascertaining the most potent available, and providing recommendations for their use.

- Further investigation of the use of soil applied chemicals for the control of whitefly and making recommendations for their future application, including safety procedures for farmers using these chemicals.

- The plant breeding programmes already referred to above should continue to investigate the breeding of suitable glabrous varieties, i.e. with less hairiness of leaf, and at the same time to balance control of whitefly with resistance already inherent in existing varieties to other diseases and insect attack.

(iii) Incentive for Timely Picking

An incentive bonus to farmers should be introduced, along the lines discussed in Section 5.4, to encourage early planting and early harvesting and marketing of seed cotton. With the introduction of adequate inducements, there will be less contamination of medium staple cotton; more of the crop will be harvested

earlier thus escaping the heavier honeydew deposits associated with mature and open cotton bolls remaining on the plant overlong, and with the later opening bolls in January.

An example of an incentive payment based on a 10% premium on the basic Grade 1 seed cotton price (1983) is given in Table 7.1. The cost of such a bonus payment would be fully covered by an increase in the lint price obtained for the cotton of only US cents 5/lb, but it is estimated that the actual lint price increase would be greater, with an average nearer to US cents 10/lb.

TABLE 7.1

Example of Incentive Bonus Payment for Early Marketing

1.	Assume a medium staple crop of 333 000 t (2.3 million kantars) of seed cotton, of which 90% is Grade 1 and of which, as a result of the incentive for early marketing, 50% is delivered to collection centres by the qualifying date.		
2.	Cost of bonus payments to farmers		
	Amount of seed cotton	=	150 000 t
	Basic price of seed cotton (1983)	=	LS 72/kantar
		=	LS 504/t
	Amount of premium (10%)	=	LS 50.4/t
	Cost of bonus payments	=	LS 7 560 000
3.	Increase in sales value of lint		
	Amount of lint (37% out-turn)	=	55 500 t
	Increased value of lint :		
	- with price increase of US cents 10/lb	=	US $ 12 210 000
		=	LS 15 873 000
	- with price increase of US cents 5/lb	=	US $ 6 105 000
		=	LS 7 936 500
4.	Inducement payment to producing corporations		
	Inducement payment on 55 500 t of lint :		
	- at US cent 1/lb	=	US $ 1 221 000
		=	LS 1 587 300
	- at US cent 2/lb	=	US $ 2 442 000
		=	LS 3 174 600

Note : US $ 1 = LS 1.3.

An alternative to paying a separate bonus would be to include the premium in the basic price with discounts applied to late deliveries; thus January deliveries might suffer a 10% price reduction and later deliveries of medium staple cotton at 20% reduction.

The introduction of incentive bonus payments for early marketing would be conditional upon acceptance by farmers of stricter discipline in cultural control, including earlier cut-off of irrigation water. This can only be achieved if all concerned in cotton production are prepared to work together to give priority to producing a saleable cotton crop free from honeydew, even at the expense of reducing availability of fodder for livestock in the main cotton producing areas. It would be realistic to include fodder and food crops in the honeydew control programme to the extent that a cropping policy for the main cotton producing areas should be agreed between the ARC, the producing corporations and the farmers. Should there be a conflict between cotton and other crops in any area, it would be advisable to eliminate cotton from the mixed cropping pattern, in the short term and until such time as reasonable control had been achieved over the whitefly.

(iv) Segregation of Seed Cotton

The programme should include a concerted effort to introduce a system of segregation of seed cotton according to the extent of honeydew contamination, based on field assessments by the entomologists. This will require strictly disciplined controls at collecting centres, and effective segregation will depend upon extension staff applying the measures and farmers accepting the controls. The cooperation of farmers will be required to segregate seed cotton at the collection centres, where it should be clearly marked (e.g. colour tagged) as being free of honeydew, or with light or heavy degrees of contamination. Cotton thus segregated in marked bags should also be separately stacked in the ginnery yard and would be ginned separately. The bales of contaminated lint would be kept in separate lots and recorded. Samples of this lint would undergo special testing and would form the basis for special marketing procedures.

It must be emphasised that it is not advocated that individual farmers should be penalised according to degree of contamination of their seed cotton. Such a system would be impossible to administer. Moreover, it is appreciated that at present the farmer does not have control of the choice or the programme for application of insecticides. However, the farmers do have control over planting and harvesting dates, and to the extent that a high incidence of contamination is due to late harvesting, the farmers must accept some responsibility for the problem, especially if they insist on late application of water to sustain greenery for fodder. If the cotton lint is not selling freely and at its full value on the world market, then the prices paid to the farmers must be adjusted downwards to reflect the prices obtained for the discounted lint. If cotton lint entirely free of honeydew can be marketed with some guarantee of non-contamination it should fetch its true market value. Such guarantees could be given to buyers of Sudanese cotton, if the foregoing measures are applied, and if there is sufficient control throughout.

(v) Inducement to Producing Corporations

As part of an all-out programme to combat the whitefly problem and to eliminate or reduce honeydew contamination, some inducement should also be offered to the producing corporations for, without their full cooperation and active

participation little improvement could be achieved. The producing corporations will also have to bear some additional expense during the honeydew control programme. It is proposed that an incentive payment be made to them, at a rate to be agreed, on all honeydew-free bales produced, to be paid in arrears after the bales have been sold.

Examples of the cost involved in paying US cents 1 or 2 per lb are included in Table 7.1. It is suggested that the inducement payments should be in the form of foreign exchange credits to be used by the producing corporations for purchasing spares, equipment etc.

APPENDIX 1

ACTION LEVELS - HELIOTHIS

In Africa treatment against Heliothis (and Diaparapsis in Botswana) is based on egg/larvae counts and a single threshold level is used throughout the season. This lies between 25 and 50 larvae/eggs per 100 plants. This level has been adopted with minor refinements in Malawi, Botswana, Zimbabwe and the Republic of South Africa.

In Australia, where inputs and yields are high, the treatment levels are much lower and recommended according to the plant growth stage. Basically threshold is relatively low in plant establishment period (pre squaring say first 40 to 45 day equivalents in Bolivia) where the terminals only are examined. In the flowering/boll setting period thresholds fall sharply in terms of square damage 15% (or 10% bolls). In the late maturing period higher square count but lower boll count is accepted (5% bolls). This attempts to take account of plant fruiting/maturation pattern.

In Arkansas a relatively low threshold is taken early as in Australia, the mid season rather higher rising to the African threshold level of 50 eggs/larvae per 100 plants.

In Barbados the threshold taken is low as in Arkansas and in fact is possibly lower in terms of larvae (12.5 per 100 plants).

In Arizona the threshold taken is the same as in Barbados.

In Texas the thresholds set are the highest of all countries. Early 50 eggs/larvae, mid 100 eggs/larvae, late 25 eggs/larvae. Reasons are sound but in part thresholds are artificial since only attractive plants are sampled.

INFESTATION TREATMENT LEVELS (per 100 plants)

Botswana	50 eggs/larvae per 100 plants or 50% infested plants.	
Malawi	25 eggs per 100 plants H. armigera.	
S. Africa	50 eggs per 100 plants or when 2 to 3 counts show steady increase, or 25 per 100 plants over long time.	
Zimbabwe	50 eggs per 100 plants.	
Arizona	10 to 12 larvae per 100 terminals.	
Arkansas	Early	25 eggs/larvae per 100 terminals
	Mid	50 eggs/larvae per 100 terminals

Texas

Early-flowering	50 eggs/larvae per 100 terminals
Mid-maturation	100 eggs/larvae per 100 terminals
Late hardening	25 eggs/larvae per 100 terminals

NB sequential sampling of dominant plants.

Early	25% damage squares
Mid	15% damage squares
Late	10% damage squares

(Stages after bloom 4 to 5 larvae per 100 terminals + 5% damage to squares or bolls. TAE Bulletin L561. 1978.)

Barbados (Recalculated as for Arkansas from station basis) but with only 4 plants/m^2 as is G. barbadense)

25 eggs	per 100 plants
12.5 larvae	per 100 plants

Alternative 10% damaged squares/bolls.

Australia Irrigated high yielding cotton

Early (establishment)	25% terminals infested with eggs
Mid (fruit formation)	20% squares damaged by larvae, falling to 15% squares damaged by larvae, as blooming declines
or	10% bolls damaged by larvae
or	50% terminals infested with eggs
Late (maturation)	25% squares damaged by larvae
or	5% bolls damaged by larvae

Nicaragua Recalculated from per station basis. Manzana - 6 400 m^2

Early/mid (30 to 115 days)	=	4 000 larvae/manzana 6 250 larvae/hectare	=	12 to 15 larvae per 100 plants
Late 115 to 180 days	=	6 000 larvae/manzana 9 400 larvae/hectare	=	21 to 23 larvae per 100 plants

Bolivia Moore's action level in trial plots.

Mid-late	10 to 12.5 larvae per 100 plants, but taking account of damage

Bolivia Adepa

A. Counts of small larvae			Converted from station equivalent as 12.5 plants/2 m^2:
to	50	days pre-bloom	20 larvae per 100 plants
to	75	days flowering	10 larvae per 100 plants
to	140	days 1st harvest	6.5 to 8.0 larvae per 100 plants
B. Counts of small larvae			Station equivalent of 10 plants/ 2 m^2
to	50	days	25 larvae per 100 plants
to	75	days	12 larvae per 100 plants
to	140	days	8 to 10 larvae per 100 plants
C. Counts of large larvae			Station equivalent of 12.5 plants/m^2
to	50	days	6.5 larvae per 100 plants
to	75	days	3.3 larvae per 100 plants
to	140	days	2.2 larvae per 100 plants
D. Counts of large larvae			Station equivalent of 10 plants/m^2
to	50	days	8 larvae per 100 plants
to	75	days	4 larvae per 100 plants
to	140	days	2.75 larvae per 100 plants

SUMMARISED

Pre-bloom	20 to 25 larvae per 100 plants
Blooming (early boll form)	10 to 12 larvae per 100 plants
Maturing-herd	7 to 9 larvae per 100 plants

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ANNEX 3

GINNING

ANNEX 3

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CHAPTER 1

INTRODUCTION

1.1 The Objectives of Cotton Ginning

The function of the cotton gin is to separate the lint fibre from the seed. There are two mechanical methods in common use - the roller gin, which is mainly used to process extra long and long staple cottons, and the saw gin which is used for medium long, medium, and short staple cotton. The saw gin is not used to process long staple cotton because of possible damage to the staple length. In addition to its principal function of separating lint from seed the modern ginnery is equipped to remove a large proportion of foreign matter from seed cotton and from lint, and is able to modify the moisture content of cotton prior to ginning and in the post ginning stage. The final stage of the process is to press the lint into bales suitable for transport and storage.

Cotton possesses its highest fibre quality and best spinning potential while it is still on the cotton plant at full maturity. All subsequent operations, whether manual or mechanical, including picking, handling, packing, cleaning, ginning, baling, up to and including spinning, may modify the natural qualities or characteristics of cotton. At best, ginning can only preserve those qualities and characteristics that are inherent in the cotton delivered to the ginnery. Thus the quality of lint produced depends primarily upon the grade and quality of the seed cotton delivered to the ginnery and in particular on the following factors:

- the variety of cotton;
- type of soil, weather, growing conditions, etc.;
- cultural and harvesting practices;
- moisture and trash content;
- pest control regimes;
- quality control at harvesting, marketing and an efficient grading system.

Thereafter lint quality is maintained and determined by:

- efficient ginning treatments and processes;
- protective packaging and storage.

Generally it is the first six factors which exert greater influence on lint quality than do extremes of ginning treatments, for the modern ginnery, if well-maintained and operated with technical expertise, will produce a standard of lint related to the grade and character of the seed cotton processed.

The good ginner should be aware of the effects of various mechanical treatments on cotton, and should possess sufficient technical knowledge to maintain machinery and equipment, to make adjustments to settings to suit the type and style of cotton, to control rates of throughput for optimum results, to control moisture content in the cotton, and to produce a well-wrapped pressed bale acceptable to the trade.

A successful ginner has two objectives. The first is to meet his obligation to the cotton grower to make the best of the seed cotton which the grower presents for processing (the price paid to the grower for seed cotton reflects the prices obtained for the lint). The second objective is to gin the cotton to give the minimum reduction in fibre spinning quality and the maximum improvement in grade, so that the lint fibre produced will meet the requirements of its ultimate users - the spinner, the textile manufacturer and the consumer.

Just as the ginner has an obligation to the grower, so too the grower has an obligation to the ginner to deliver seed cotton of an acceptable even grade and quality. Harvesting should commence when bolls are fully open and mature, nor should harvesting be delayed, and damaged, diseased, and stained cotton should be separated from fully opened, mature, good clean locks of cotton. Cotton should not be picked wet and the grower should inspect his hand-picked cotton and pick it over, separating stained or damaged locks from the good grades. Hand-picked seed cotton should be separated and bagged according to pickings and selection. Grading at the ginnery must be efficiently carried out and the different grades segregated and stored separately while awaiting ginning.

The factors which determine the selling price of cotton fibre are:

- lint grade;
- staple length;
- fibre fineness and maturity;
- fibre strength.

Grade is determined principally by colour and the amount of foreign matter present. The ginning process may do little to change the colour of the cotton, but can reduce the foreign matter, and can change the staple length only to a limited extent (apart from staple damage caused by malfunctioning machinery). The ginning process cannot affect fineness, maturity or strength of fibre.

1.2 Seed Cotton Varieties

Cotton fibres vary in staple length from about 15 to 42 mm. The main seed cotton varieties grown in Sudan are as follows:

Variety	Staple length
Barakat	35-40 mm ($1\ ^{3}/_{8}$ - $1\ ^{9}/_{16}$ inch)
VS	37-40 mm ($1\ ^{7}/_{16}$ - $1\ ^{9}/_{16}$ inch)
Acala 69/2	29-32 mm ($1\ ^{1}/_{8}$ - $1\ ^{1}/_{4}$ inch)
Acala Barac	26-29 mm ($1\ ^{1}/_{32}$ - $1\ ^{1}/_{8}$ inch)
Acrain	25-26 mm (1 - $1\ ^{1}/_{32}$ inch)
Alba	25-27 mm (1 - $1\ ^{1}/_{16}$ inch)

Barakat and VS have staple lengths in the long and extra long categories, but are commonly referred to as long staple varieties. The Acala (upland) varieties have staple lengths in the medium long and medium categories, but are commonly referred to as medium staple varieties. Acrain and Alba are short staple varieties. In this report the terms long staple, medium staple and short staple refer to the varieties as outlined above.

1.3 Development of Cotton Ginning in Sudan

The ginning of the Sudanese cotton crop has long been the responsibility of the cotton producing organisations, going back historically to the Sudan Plantations Syndicate and its pioneering work at Zeidab leading to the establishment of the first ginnery there in 1910, followed by construction of ginneries at Barakat, and those of the Kassala Cotton Company for the Gash and Tokar cotton areas. Cotton growing required ginning facilities and as there was no independent ginning organisation, the ginning facilities were provided by the producing organisations. Thus cotton growing and ginning in the Sudan complemented each other and developed together.

The rapid increase in cotton production arising from the development of the Gezira plain following the opening of the Sennar Dam in 1926, with subsequent extensions to the scheme to some 2 million acres in all, necessitated the installation of considerable ginning capacity to keep pace with production. Just as the Syndicate had developed the necessary ginning facilities to process its production of seed cotton, so the Sudan Gezira Board established the necessary ginneries to enable the increasing cotton crop of the Gezira plain to be processed.

Following the development of the Blue Nile and White Nile pump schemes by the private sector, privately owned ginneries were established to process the pump scheme cotton. More recently, new producing corporations with schemes at Suki, New Halfa, and Rahad followed established procedures and incorporated ginning facilities into their schemes.

Processing criteria for Sudanese cottons follow established and accepted methods, the roller gin being used to process extra long and long staple cotton while the saw gin is used for medium and short staple cotton. Thus most of the older ginneries, particularly in the Gezira, are of the roller ginning type. Saw ginning was introduced to Sudan in the mid-1920s for processing the short staple rain grown cotton produced in the Nuba Mountains area and the Kassala/Gedaref area. The introduction of medium staple varieties of Acala and its derivatives on large scale irrigation schemes necessitated the use of medium high capacity saw gin factories which were installed at New Halfa, Fau, and Kassab (for the Suki Scheme).

In recent years, the introduction of medium staple varieties on the older schemes, such as Gezira, has led to the increasing use of roller ginneries for processing medium staple cotton. The type of roller gin in use has a much lower throughput when processing medium staple as opposed to long staple cotton, and together with the higher yields of medium staple varieties, this has led in turn to increasing pressure on the available ginning capacity.

1.4 Present Situation

1.4.1 Existing Facilities

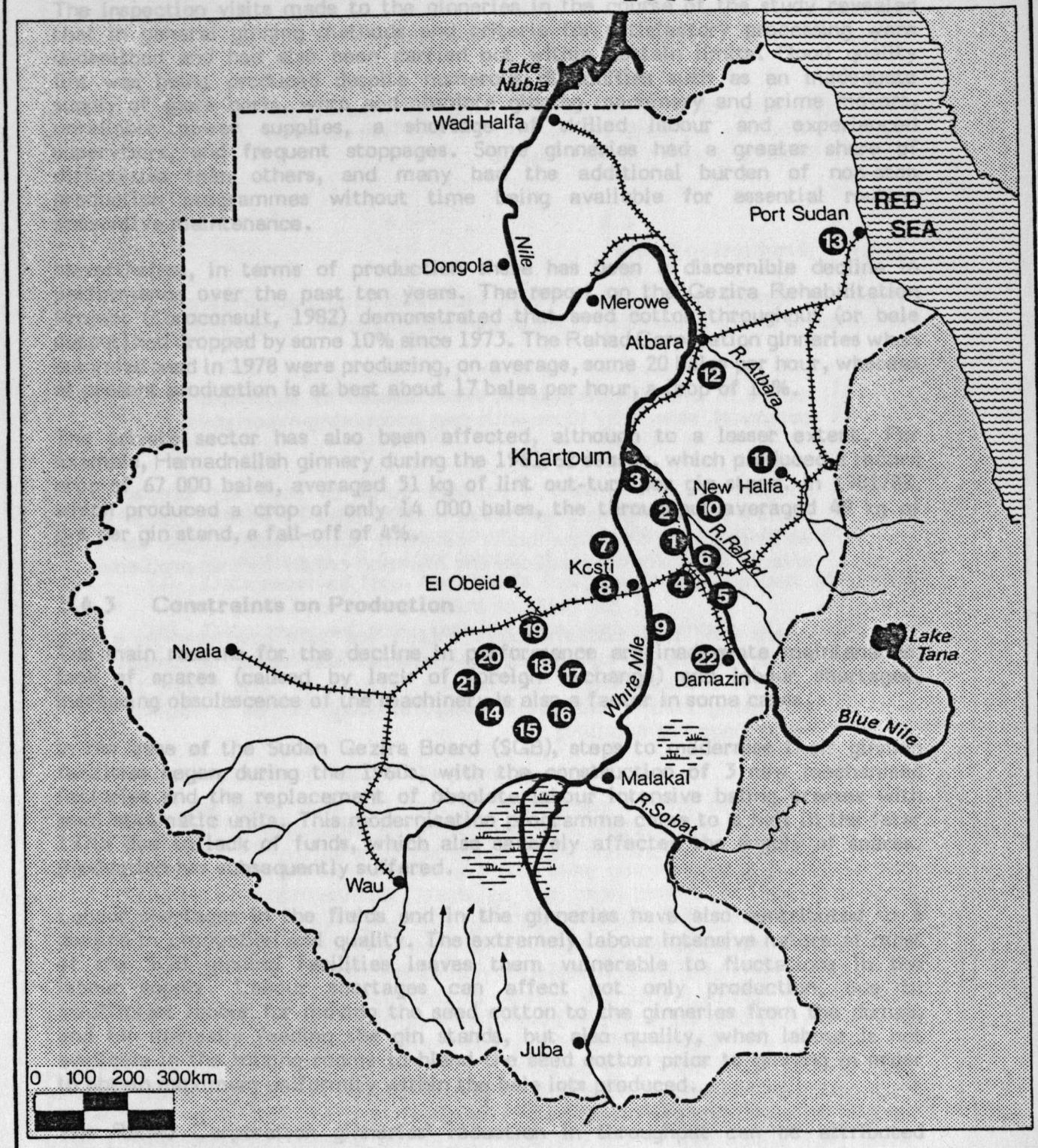
A list of existing ginning facilities, their location and ownership, is given in Table 1.1. It will be noted that five of the ginneries consist of more than one ginning factory. The total number of ginning factories is 39. A map of the ginnery locations is shown on Figure 1.1. A complete inventory of the ginning machinery and ancillary equipment at each site, with as much detail regarding type, characteristics, age and condition as it was possible to collect, is given in Annex 1 - Inventory. Annex 1 also provides a description of the buildings and infrastructure at each ginnery.

TABLE 1.1

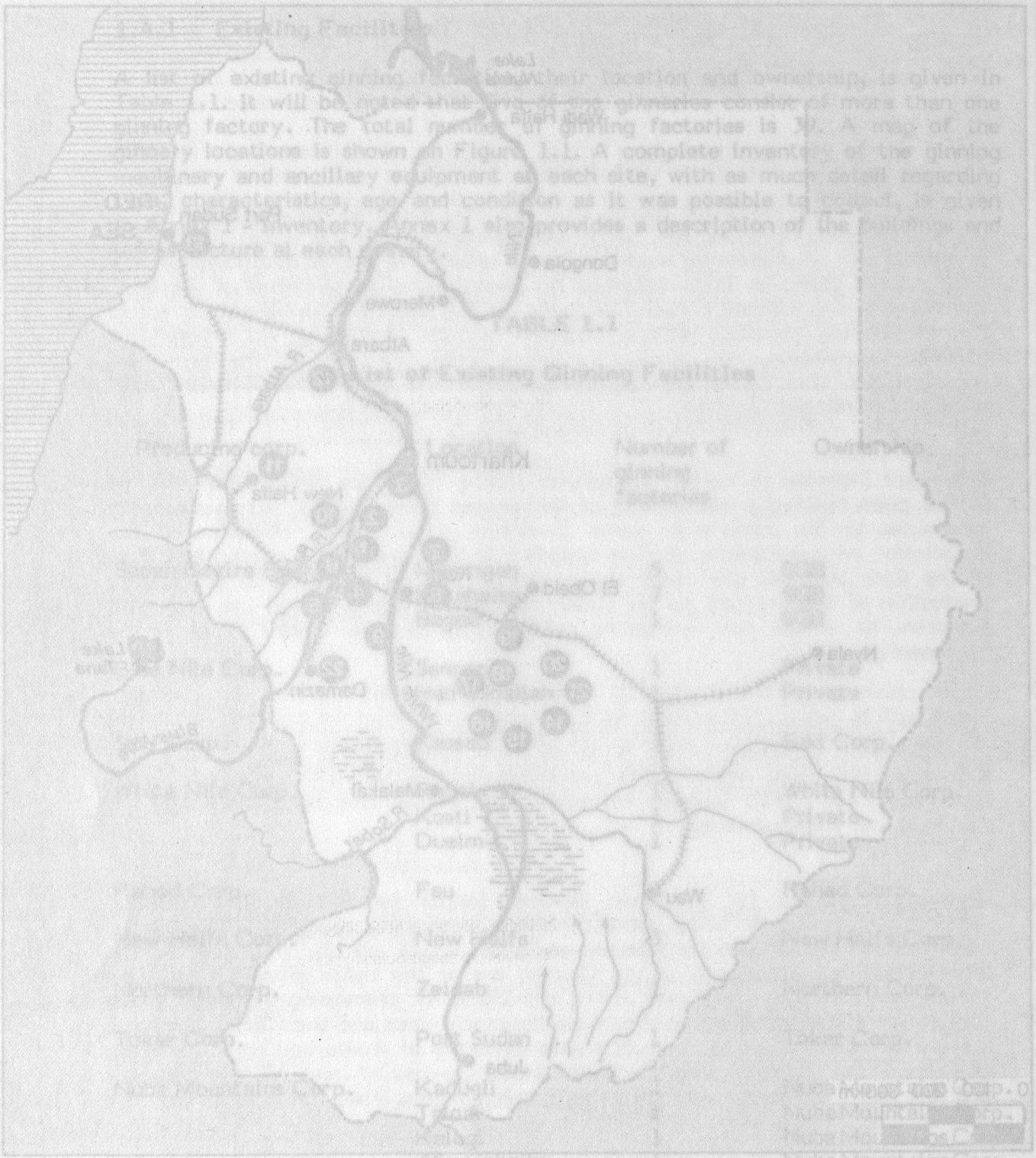
List of Existing Ginning Facilities

Producing corp.	Location	Number of ginning factories	Ownership
Sudan Gezira Board	Marangan	5	SGB
	Hasaheisa	7	SGB
	Bageir	1	SGB
Blue Nile Corp.	Sennar	1	Private
	Hamadnallah	1	Private
Suki Corp.	Kassab	3	Suki Corp.
White Nile Corp.	Rabak	1	White Nile Corp.
	Kosti	1	Private
	Dueim	1	Private
Rahad Corp.	Fau	4	Rahad Corp.
New Halfa Corp.	New Halfa	3	New Halfa Corp.
Northern Corp.	Zeidab	1	Northern Corp.
Tokar Corp.	Port Sudan	1	Tokar Corp.
Nuba Mountains Corp.	Kadugli	1	Nuba Mountains Corp.
	Talodi	1	Nuba Mountains Corp.
	Kalogi	1	Nuba Mountains Corp.
	Abu Gebeiha	1	Nuba Mountains Corp.
	Umm Berembeita	1	Nuba Mountains Corp.
	Semeih	1	Nuba Mountains Corp.
	Dilling	1	Nuba Mountains Corp.
	Lagowa	1	Nuba Mountains Corp.
Mechanised Farming Corp.	Damazin	1	MFC

Locations of Ginneries



1. Marangan
2. Hasaheisa
3. Bageir
4. Sennar
5. Hamadnallah
6. Kassab
7. Dueim
8. Kosti
9. Rabak
10. Fau
11. New Halfa
12. Zeidab
13. Port Sudan
14. Kadugli
15. Talodi
16. Kologi
17. Abu Gebeiha
18. Umm Berembeita
19. Semeih
20. Dilling
21. Lagowa
22. Damazin



1.4.2 Recent Performance

The inspection visits made to the ginneries in the course of the study revealed that in general ginning methods and criteria for satisfactory processing were understood and had also been carried out within certain limits. Good quality lint was being produced despite numerous difficulties such as an inadequate supply of spare parts, worn and obsolete ginning machinery and prime movers, unreliable power supplies, a shortage of skilled labour and experienced supervisors, and frequent stoppages. Some ginneries had a greater share of difficulties than others, and many had the additional burden of non-stop production programmes without time being available for essential routine preventive maintenance.

Nevertheless, in terms of production there has been a discernible decline in performance over the past ten years. The report on the Gezira Rehabilitation Project (Euroconsult, 1982) demonstrated that seed cotton throughput (or bale output) had dropped by some 10% since 1973. The Rahad Corporation ginneries when commissioned in 1978 were producing, on average, some 20 bales per hour, whereas at present production is at best about 17 bales per hour, a drop of 15%.

The private sector has also been affected, although to a lesser extent. For example, Hamadnallah ginnery during the 1961/62 season, which produced a record crop of 67 000 bales, averaged 51 kg of lint out-turn per gin stand. In 1981/82, which produced a crop of only 14 000 bales, the throughput averaged 49 kg of lint per gin stand, a fall-off of 4%.

1.4.3 Constraints on Production

The main reasons for the decline in performance are inadequate maintenance, lack of spares (caused by lack of foreign exchange) and labour shortages. Increasing obsolescence of the machinery is also a factor in some cases.

In the case of the Sudan Gezira Board (SGB), steps to modernise their ginning facilities began during the 1960s, with the construction of 3 new mechanised factories and the replacement of obsolete labour intensive baling presses with semi automatic units. This modernisation programme came to a halt in the later 1970s due to lack of funds, which also severely affected the supply of spares. Production has subsequently suffered.

Labour shortages in the fields and in the ginneries have also contributed to a decline in production and quality. The extremely labour intensive nature of most of the SGB ginning facilities leaves them vulnerable to fluctations in the labour supply. Labour shortages can affect not only production, due to insufficient labour for moving the seed cotton to the ginneries from the dumps, and for manually feeding the gin stands, but also quality, when labour is not available in the mixing rooms to blend the seed cotton prior to ginning in order to obtain maximum uniformity within the bale lots produced.

The Rahad Corporation ginneries' reduction in throughput can be attributed mainly to maintenance problems, although these are caused as much by poor application of spares as by their non-availability. A combination of management pressure to gin out the crop as quickly as possible with a total lack of planned maintenance (the factories are operated on a 24 hour per day, 7 day per week basis, with no time allowed for maintenance) has resulted in a deterioration of the machinery out of all proportion to its age.

The situation in the private sector has remained relatively stable, and the fall-off in performance can be attributed mainly to lack of pressure. The ginneries are operating well below capacity, as seen in the example of Hamadnallah, and this invariably results in slightly lower output.

Other operating difficulties include stoppages caused by honeydew problems, mainly affecting medium staple cotton, and unreliability of power supplies, which is a major problem at New Halfa.

1.4.4 Production Costs

There are various problems associated with determining accurate and up to date information on the production costs of existing ginneries. These include :

- delays in preparing accounts, often caused by shortages of accounting personnel, especially those with cost accounting experience;

- budgets are not always a reliable guide as they are prepared nine months prior to ginning and three months prior to sowing. Large volume variances can therefore occur between actual and budget data. The effects of recent devaluations and inflation create further problems;

- where long and medium staple cotton are both processed in a roller ginnery there is no distinction between the costs of ginning each variety. Medium staple will usually take up to 50% longer to gin so increasing labour and power costs, although it has a slightly higher percentage lint out-turn;

- costs also do not necessarily reflect the true value of the plant as depreciation charges are based upon the original book value, taking no account of its present worth or replacement value.

Comparisons of costs between existing ginneries do not have much significance because of differences in the methods of ginning; the type, capacity and age of equipment; the mix of cotton varieties processed; and the volume of seed cotton available for ginning. With the proviso of the above limitations, recent average production costs by scheme are shown in Table 1.2. The data has been obtained from the Bank of Sudan and is abstracted from expenditure and budget accounts received from the producing corporations. Some deviations are noted from the data recorded following information supplied directly by the ginneries, relating to 1981/82 and 1982/83. Additionally it is noted that the estimates for Blue and White Nile appear low as the average cost of the private ginneries was LS 6.54 per kantar of lint in 1981/82 (see Annex 7 Section 2.1.3).

Generally costs of saw ginning should be lower than the equivalent cost of roller ginning long staple because of the higher yield and greater mechanisation. This appears to be supported by the case of Rahad which has experienced very high annual throughputs.

TABLE 1.2

Ginning Costs
(LS per kantar of lint)

		1981/82 estimates	1982/83 budget	1982/83 provisional estimates[1]
Gezira	RG	6.6[2]	6.3	-
Blue Nile	RG	4.0	7.0	-
Suki	SG+RG	6.0	6.0	7.23
White Nile	RG	5.0	6.5	-
Rahad	SG	3.14	3.2	-
New Halfa	SG	5.0[3]	3.2	-
Tokar	RG	3.0	4.0	-
Zeidab	RG	-	-	7.0
Damazin		-	-	7.0
Nuba Mountains		4.0[4]	5.0	-

Notes : (1) Provided by ginneries.
(2) Financial analysis department of SGB provisionally estimates cost of ginning at LS 6.2 per kantar of lint for 1981/82.
(3) Data received from New Halfa indicate an average cost of ginning of LS 6.7 per kantar of lint for 1981/82.
(4) Data received show that average cost of ginning at Kadugli was LS 4.2 per kantar of lint.

Source : Bank of Sudan (except where stated)

1.5 Assessment of Future Requirements

A number of existing ginneries are old and the machinery if not obsolete is certainly obsolescent, while there is little in the way of mechanical handling, automation or conveying systems. Some of the older ginneries have benefited from a programme of improvements, such as the replacement of baling presses, electrification, and installation of conveyance systems, but much remains to be done to bring the ginning facilities up to optimum efficiency and to provide adequate capacity for Sudan's diversified and expanding cotton crop.

The work required at existing ginneries includes both rehabilitation and improvements. Rehabilitation is required to make up for the backlog of maintenance and to restore existing facilities to efficient working order; it will generally involve the supply of spare parts and the major overhaul or the replacement of some equipment. Improvements are proposed to modernise or upgrade the ginneries where appropriate, with a view to overcoming specific problems such as labour shortages, increasing throughput and raising the grades and quality of the lint produced. For the purposes of the study, each individual investment in existing ginneries has been classified as either rehabilitation or improvement. In practice, these two categories inevitably overlap, as in the case of the replacement of existing equipment with equipment of higher capacity (which is classified as an improvement).

In Chapter 2, each stage of the ginning process is described in general terms, and possible improvements are discussed with reference to particular factories where appropriate. In Chapter 3, details are given of the specific proposals for rehabilitation and improvements at each ginning factory.

It is expected that the rehabilitation and improvements at existing factories proposed in this report, together with the improvements and new factories at the SGB ginneries already planned as part of the Gezira Rehabilitation Project (GRP), would provide most of the additional capacity required to meet projected increases in cotton production. However, some further additional capacity in the form of new ginning factories would also be required. Projected crop production, the present and future capacity of existing ginneries and the requirements for additional new capacity are discussed in Chapter 4.

Proposed infrastructural works and improvements in ginnery power supplies are described in Chapters 5 and 6, respectively.

CHAPTER 2

GINNING METHODS AND PRACTICES

2.1 General

Table 2.1 summarises the principal characteristics of each of the existing ginning factories.

The roller gin installations are in the main labour intensive, with the minimum of handling and conveying machinery. The exceptions to this are 4 of the 13 factories belonging to the SGB. None of the roller gin factories is equipped with cleaning machinery.

All the saw gin installations are mechanised in as much as the seed cotton is pneumatically conveyed to the gin stands within an enclosed system; the cotton lint is conveyed in a similar manner to the bale press. Cleaning of the seed cotton and lint takes place throughout the pneumatic systems, varying in degree according to the amount of cleaning machinery installed.

2.2 Seed Cotton: Yard Handling and Storage

2.2.1 Present Situation

Seed cotton is, without exception, purchased, transported, and stored in sacks, each sack containing up to 140 kg (1 kantar). The physical size of these sacks requires large numbers of labourers to offload the means of transport, which may be camels, donkey carts, light railway, or road vehicles.

Handling and stacking in the ginnery yards is entirely manual, sacks being either rolled across the ground or moved on hand carts, one at a time, and stood on end against each other. The seed cotton is segregated by grades, and after grading the cotton is arranged in the stacking areas in lots of 1 200 to 1 300 sacks, which will in turn produce a 300 bale lot of lint.

Movement from the stacking areas to the ginning factories is mainly by tractor and trailer combinations, carrying from 6 to 15 sacks, depending on the site. The most efficient type of trailer in terms of quickness and ease of manual loading/offloading is the 'Gezira' type, a strongly built, low bed trailer developed and used by the SGB. Other trailers of the conventional type present loading problems because of the relatively high bed height, and consequent smaller loads. Road vehicle trucks in use at some sites also present problems of loading, although not of carrying capacity.

2.2.2 Improvements

It is proposed that where required additional tractors and trailers be provided for seed cotton transport. As long as the present system of sacks remains in use, then without doubt the 'Gezira' type of trailer is to be recommended for use throughout the Sudanese ginning industry. The design can easily be reproduced from those in use at the SGB sites, and they can be locally manufactured, using imported components.

TABLE 2.1

Summary of Ginning Equipment at Existing Ginneries

Ginnery	Factory Nr	Gin stands Nr	type	model/ date	Seed cotton handling	Seed cotton humidification	Seed cotton cleaning	Lint handling	Lint cleaning	Bale presses Nr	type	date
Marangan	1	92	R	M2	LI	A	-	LI	-	2	M	1953
	2	92	R	M2	LI	A	-	LI	-	2	M	1954
	3	92	R	M2	LI	A	-	LI	-	2	M	1960
	4	92	R	M2	LI	A	-	PM	-	2	SA	1977
	11	92	R	M2	FM	A	-	FM	-	2	SA	1964
Hasaheisa	5	92	R	M2	LI	A	-	PM	-	2	SA	1977
	6	92	R	M2	LI	A	-	PM	-	2	SA	1978
	7	92	R	M1(1)	LI	A	-	PM	-	2	M/SA	1952/80
	8	92	R	M1(1)	LI	A	-	PM	-	2	SA	1980
	10	20	R	M2	FM	-	-	FM	-	1	SA	1954
	12	92	R	M2	FM	A	-	FM	-	2	SA	1964
	13	46	R	M1	LI	A	-	LI	-	2	M	1950
Bageir	14	100	R	M2	FM	A	-	FM	-	2	SA	1964
Sennar	-	60	R	M1(2)	PM	A	-	PM	-	1	M	1957
Hamadnallah	-	68	R	M2	PM	D	-	LI	-	1	M	1954
Kassab	1	65	R	M1	LI	-	-	LI	-	1	M	1955
	2	3	S	1962	FM	-	I	FM	-	1	SA	1961
	3	3	S	1976	FM	H	I	FM	-	1	SA	1976
Dueim	-	48	R	M2	PM	-	-	LI	-	1	M	1959
Kosti	-	48	R	M2	PM	A	-	LI	-	1	M	1955
Rabak	-	100	R	1954	LI	A	-	LI	-	2	M	1954
Fau	1,2,3,4	12	S	1976	FM	H	I	FM	S(4)	4	SA	1978
New Halfa	1,2,3	9	S	1967	FM	-	I	FM	-	3	SA	1967
Zeidab	-	40	R	M1(3)	LI	-	-	LI	-	1	M	1926
Port Sudan	-	80	R	M1	LI	-	-	LI	-	1	M	1930
Kadugli	-	4	S	1957	FM	-	-	FM	-	1	SA	1957
Talodi	-	3	S	1957	FM	-	-	FM	-	1	SA	1957
Kologi	-	4	S	1955	FM	-	-	FM	-	1	SA	1955
Abu Gebeiha	-	4	S	1954	FM	-	-	FM	-	1	SA	1954
Umm B'beita	-	4	S	1929	FM	-	-	FM	-	1	M	1930
Semeih	-	4	S	1929	FM	-	-	FM	-	1	SA	1966
Dilling	-	4	S	1929	FM	-	-	FM	-	1	M	1930
Lagowa	-	4	S	1954	FM	-	-	FM	-	1	SA	1954
Damazin	-	3	S	1976	FM	H	I	FM	S	1	SA	1979

Key :
- Gin stands : R - Roller; S - Saw; M1 - Model 1; M2 - Model 2.
- Handling : LI - Labour intensive; PM - Partly mechanised; FM - Fully mechanised.
- Humidification : A - Atmospheric; D - Ducted; H - Humidaire unit.
- Cleaning : I - Inclined cleaners; S - Saw type lint cleaners.
- Bale presses : M - Manual operation; SA - Semi-automatic operation.

Note :
(1) 12 Nr M2 gins
(2) 20 Nr M2 gins
(3) 10 Nr M2 gins
(4) Factory Nr 1 only

Alternative forms of storage and yard transporting can and should only be applied on an experimental basis where conditions permit. The variety of seed cotton also has to be taken into account. Bulk storage can be considered in two forms:

(i) large volume bulk storage buildings;

(ii) modules.

System (i) is limited in its application because of the extremely high capital cost involved in providing multiple units of storage buildings sufficient in number to hold all incoming seed cotton. Seed cotton is very bulky in loose packed condition. Limitations on the distance over which the conventional pneumatic unloading systems are able to convey seed cotton would also add greatly to the cost, as multiples of the system would also be required. However, applications for system (i) are discussed in the following section.

System (ii), seed cotton moduling, is feasible where mechanised ginneries already exist, or are proposed, whether they are roller or saw. The roller ginneries can be discounted, however, as it is proposed that a limited form of bulk storage be utilised for the long staple varieties as an aid to improving the blending of seed cotton. The module system would therefore be applicable only to the saw ginneries which process the medium staple varieties for which blending is not such a critical factor, although the system would result in some blending.

It is proposed that the new saw gin installation at Marangan (SGB), which is planned to be provided under the GRP, should be designed to include module unloading systems, and if proved successful, these could be adopted at other sites where modern saw gin factories already exist.

The module system would come into effect after the sacks of seed cotton have been graded into their respective lots. A mobile module builder would then produce 10 tonne modules of seed cotton emptied from the sacks, and the moduled lots of seed cotton would be held in reserve until called into the ginnery for processing. The empty sacks would be returned immediately to the collection centres (after repair) resulting in a much reduced number being required in each buying season. When called in for processing, the modules would be carried to the ginnery unloading bays by module transporters, several types of which are available on the market.

2.3 Seed Cotton : Pre-Gin Mixing and Blending

2.3.1 Present Situation

Apart from the production of short staple cotton in the rainfed areas, cotton production in Sudan for many years was concentrated upon irrigated production of long staple cotton, and a system of grading evolved over the years which was designed to measure and determine both seed cotton and lint standards which were peculiar to long staple cottons only, and which would provide comparable lint standards from pre-set seed cotton grades. It is stated in Annex 5 that the grading system for seed cotton is satisfactory and, especially for long staple cotton, no change is envisaged at present. It is for the long staple varieties that extra care is required in grading as the price differentials between the various grades of lint are considerable.

Ideally the ginning programme for long staple cotton should be planned by the chief cotton grader for the ginnery or ginning complex, who can put together even running lots from his segregated graded stocks of seed cotton in the storage area. Generally cotton of only one grade is ginned at a time. However, as it is possible that seed cotton within one grade could be slightly dissimilar, a mixing/blending system can be used to further ensure an even run of lint bales.

Mixing or blending facilities exist at most of the roller ginning installations, either as separate rooms from which the seed cotton is drawn by a pneumatic system into the gin hall, or simply as segregated areas behind the gin stands. In all cases, the blending is manually performed by labour emptying the sacks of seed cotton on to the floor and then physically 'mixing' the cotton. This operation is time consuming and labour intensive, and at best only a limited blending is achieved. In recent years mixing has rarely been fully implemented because of labour shortages.

2.3.2 Improvements

It is proposed that effective blending be achieved, in 300 bale lots, by the use of purpose built blending halls, which would be, in effect, small bulk stores. The arrangement and operation of these blending halls would be as follows. The sacked seed cotton is brought from the yard storage areas to a paved unloading apron alongside the blending hall. The seed cotton is emptied from the sacks and fed to two pneumatic suction telescopes, which are used alternately. From these it is delivered via an air separator to an overhead screw conveyor running along the length of the blending hall (30 m long x 10 m wide) which is divided into two bays, each 15 m x 10 m. The seed cotton can be deposited into whichever bay is selected by means of slide valves, and is spread over the surface area of the bay as it is delivered, up to an average depth of about 8 m. 1 200 m^3 of seed cotton at 141 kg/m^3 will produce a 300 bale lot at 34% lint out-turn, given an average weight per bale of 185 kg (408 lb). The seed cotton is removed from each bay by underfloor suction piping and conveyed pneumatically to the ginning hall. With the use of two bays in the blending hall, a second lot, which may be of a different grade, can be built up while the first lot is being ginned. The system not only mixes the seed cotton prior to delivery to the ginnery, but also removes some of the trash content from the seed cotton through the pneumatic systems.

The benefit of improved uniformity ratios within each bale, and of more even-running lots of bales, would be in the region of the equivalent of the value of half a grade over 60% of long staple ginnings, e.g. for the Gezira crop of long staple cotton, say 300 000 bales, the benefit could be US$ 5 per bale on 180 000 bales or US$ 900 000.

A system similar to the above has been adopted for the Egyptian cotton ginning industry, which has recently undergone major rehabilitaton schemes. However, in Egypt, blending is achieved in two stages through the use of large bulk stores in addition to the blending hall. A separate bulk store can be provided for each grade of seed cotton. The bulk store is sub-divided into small bays so that the seed cotton making up one lot is distributed equally into three bays; it is then drawn from those bays and delivered into one bay in the blending hall, where alternative 'layering' of the seed cotton from the three bays ensures complete and thorough blending by the time the seed cotton reaches the gin stands. The use of the bulk stores also allows considered flexibility in the ginning programme. However, it is doubtful whether the premiums attracted by Sudanese

cotton would be sufficient to justify the relatively high cost of providing the bulk stores and associated conveying equipment. It is therefore proposed that blending facilities should be confined at this stage to the blending hall described above, although it would be possible to add at least one large bulk store in the future.

2.4 Seed Cotton: Conveyance, Cleaning and Humidification

2.4.1 Conveyance and Cleaning - Roller Ginneries

Most of the roller ginneries rely on manual feeding of the gin stands, although a few are partly mechanised in that they have pneumatic systems to deliver the seed cotton to a position near to the gin stand lines. The four fully mechanised roller ginneries of the SGB have a pneumatic system to deliver seed cotton directly to each gin stand. No roller ginnery is equipped with cleaning machinery, although where pneumatic conveying systems exist some cleaning takes place in the removal of fine trash and dust.

The roller ginneries are involved primarily in the processing of long staple varieties. As long as clean, hand picked cotton is available, cleaning systems would not be required for the majority of the crop. However, this depends on there being sufficient labour and supervision in the fields to maintain the extremely clean standards set in the past. Unfortunately, such standards have become subject to the erratic supply of labour, resulting in some particularly poor years regarding seed cotton quality. The Euroconsult report noted that 'hand snapping' of seed cotton was evident in 1980/81, due that particular season to the shortage of picking labour.

To eliminate the risk factor where labour is concerned, an essential improvement in all factories, where it is practical to do so, is the installation of an integrated system of conveyance and cleaning, which will not only clean the seed cotton prior to feeding to the gin but which will reduce the amount of ginnery labour required.

There are a number of proven systems on the market but for hand-picked seed cotton the simplest and most appropriate is based on a pneumatic suction system which draws seed cotton from the delivery point or blending hall to a separator which in turn delivers air-opened seed cotton to a cleaning machine. Dust and fine trash is extracted by the suction system and exhausted through the separator. Heavier trash is extracted in the cleaning machine. A secondary suction system can pick up seed cotton from the cleaning machine or the separator and deliver it through cotton droppers on to a feeding platform where it can be fed manually to the gins. Alternatively the seed cotton can be delivered from cleaner or separator into a conveyor/distributor and automatically fed into the gin hopper/feeders. Each pneumatic system used extracts dust and fine trash and opens out the locks of cotton. Opened cotton gins more freely and throughput is improved.

The cleaning machines should be gravity type multi-cylinder cleaners of not more than six or seven cylinders. They should be fitted with a bypass, so that top quality long staple cotton can be bypassed while lower and medium grade long staple and all medium staple cotton is passed through the cleaner. Periodic test checks should be used in which samples would be drawn from the lint with and without the use of cleaners. Should tests prove that there is little or no improvement in grade of lint, the cotton should not be unnecessarily machined

and the cleaner should be bypassed. The seed cotton grader/classifier should carry out the test along with the ginnery engineer. After some time both will be able to assess which grades of seed cotton will best benefit from machine cleaning with only occasional tests being made.

The improvement in the grade of seed cotton after cleaning is apparent to the eye, and the cost benefits from the use of pneumatic conveying systems are substantial. Seed cotton in the lower grades of long staple varieties could be improved by up to one full grade, while medium grade cotton could improve by half a grade. On a 300 000 bale crop in the Gezira, for instance, this would provide increased annual revenue of US$ 3 million. There would also be savings in labour costs on handling seed cotton from delivery point to gin, and these savings would be in excess of the additional power costs and the depreciation on the equipment.

2.4.2 Conveyance and Cleaning - Saw Ginneries

All existing saw ginneries are already equipped with pneumatic/mechanical systems involving cleaning equipment in varying degrees. For hand-picked medium staple cotton this is generally confined to a pneumatic elevator system from the delivery point to a separator thence to an inclined cleaner delivering to a conveyor/distributor which feeds cotton to each saw gin. As only three or four saw gins are required to gin the equivalent throughput of 100 roller gins relatively short conveyor lengths are required. Before seed cotton reaches the saw gin it passes through an extractor/feeder which further cleans the cotton. The saw gin process also has a cleaning effect on the cotton, and the pneumatic conveyance from the saw gin to the condenser further cleans the lint. The overall effect is that saw ginned lint is much cleaner than roller ginned lint, and if all other characteristics are even, saw ginned lint earns a premium over roller ginned lint for its cleanliness.

The saw ginneries are used for medium and short staple cotton for which mechanical harvesting may be used. The cleaning of machine harvested cotton presents particular problems and requirements which are discussed separately in Section 2.9.

2.4.3 Humidification

Humidification is an increasingly important factor in the modern ginning system and is considered essential in conditions, such as those found in the Sudan, of extremely low ambient humidity. Unfortunately, the use of humidification systems causes difficulties in the presence of honeydew in seed cotton, as the stickiness problems normally associated with honeydew are greatly magnified by the addition of moisture.

Almost all the roller ginning factories are equipped with atmospheric spray systems, some dating back to the 1920s. The older systems performed well enough and were easily maintained provided spares were available. However, both maintenance and peformance are now affected by the obsolescence of these systems, as spares are no longer readily available. Another point affecting the efficiency of atmospheric systems is that the seed cotton must be stacked within the gin hall for 24 hours for it to absorb the optimum 7% moisture content necessary to keep fibre breakage to a minimum during the ginning process. This is hardly likely to succeed when labour involved in placing the cotton in the gin hall is in such short supply that the seed cotton is delivered directly from the storage yard into the gin stand. Fibre quality is therefore at risk.

With the proposed mechanisation of seed cotton handling, atmospheric humidification systems would no longer be applicable. A humidifier directly coupled into the pneumatic/mechanical handling system, of the type which already exists in the modern saw ginning factories, would provide accurate control of seed cotton moisture content at all times throughout the ginning process. However, such systems do have drawbacks in that oil or gas fuel is normally required to achieve the necessary water evaporation rate, coupled with a high pressure fan. Alternative systems are available which are more suitable for roller ginneries and which do not require fuel. An example of such a system is installed at Hamadnallah, where it has operated satisfactorily since 1954. It is based on a large volume, low pressure fan which draws air through a spray type air washer and then delivers the moist air through distribution ductwork to adjustable discharge diffusers located just above each gin feed hopper.

The honeydew problem is the same regardless of which system is used. However, both systems are controllable, and can be varied or shut down altogether to suit the extent of the honeydew contamination, and at the same time at least bring the moisture content somewhere near the optimum level to retain the fibre characteristics.

The high throughputs of modern saw ginneries can give rise to two main problems:

(i) fibre breakage, which is inversely proportional to moisture content;

(ii) static, caused by the fast moving seed cotton passing through steel piping and ducting, which at best only causes chokages in the system and, at worst, causes fires due to friction and sparks, both resulting in excessive downtime and loss of production.

The existing humidification system at Damazin is used to good effect. Fau provides a good example of static problems. Although humidification systems are installed, these are not in use because of the incidence of honeydew, resulting in considerable downtime due to fires.

The Nuba Mountains ginneries provide examples, not so much of fires, but of downtime due to static chokages. No humidification systems are installed in the Nuba Mountains ginneries, yet they could be used to good effect as honeydew is rare in the rain grown cottons.

2.5 Ginning

2.5.1 Roller Gins

The roller gin used in the Sudan is the McCarthy type having a single roller which draws the lint fibre across a fixed knife while the action of a moving reciprocating knife severs the fibre from the seed. The single roller gin is limited in its throughput. It was designed to process small quantities of fine hand-picked long staple cotton and to be manually fed. Throughput rates vary considerably depending upon the variety of cotton, the lint out-turn percentage, and the condition of the seed cotton. Generally, extra long staple of the G. Barbadense variety roller gins freely while medium staple G. Hirsutum varieties do not gin as freely and outputs are lower.

The 21 operating roller gin installations in the Sudan have a total of 1 595 gin stands. By far the largest number are Platt Model 2 single roller single acting Barakat double stripper gins. Most of the remainder are Platts/Dobson Barlow Model 1 single acting single roller (SASR) gins. The gin stands date from between 1920 and 1978, with the older Model 1 gins being gradually phased out and replaced by the improved Model 2 gins. There are also 100 gin stands of German origin (Alfred Toepfer) at Rabak, also SASR.

Processing capacity is usually expressed in lb lint per hour per gin stand and for Model 2 gins can vary from 51 lb (23 kg) to 86 lb (39 kg) on medium staple, and from 73 lb (33 kg) to 110 lb (50 kg) on long staple varieties. The output differences between gins are attributable to operating, climatic and agricultural (honeydew) factors at the various factories, while the output differences by variety are due to the tenacious nature of the woolly Acala type seed to which the lint adheres more strongly, making it difficult for the rollers to remove the lint quickly, compared with the Barakat 'black' seed from which practically all the lint is easily and quickly removed. The lower medium staple output from the single roller gin stand has led to some shortfall in capacity as a result of increasing areas coming under the medium staple varieties, displacing the traditional long staple types.

It is recommended that the remaining Model 1 gins should be replaced, but consideration should be given to adopting gins similar to those which have been installed in considerable numbers in Egypt. This type of gin would be eminently suitable for use in the Sudan; it is recommended that Sudanese ginnery engineers visit Egypt to see the gin in operation and to discuss its relative merits and demerits with the Egyptian authorities.

The single roller type of gin performs more efficiently if it is fed continuously with cotton, and if the cotton is dispersed evenly along the full length of the machine and its roller. This can be attained more readily by equipping the gin with a hopper/feeder which sits above the gin and provides the gin with a measured and continuous supply of seed cotton, rather than by hand-feeding direct to the gin. The hopper/feeder improves the rate of throughput of the gin, compared with a manually-fed gin, by 10% to 12% (taking the average for a whole ginning season) and one man can usually keep at least four gin hoppers supplied by manually loading the hoppers. By contrast, a labour intensive ginnery without hopper/feeders requires one person to feed each gin with seed cotton, and additional labour to carry seed cotton from the reception area to the gins.

The hopper/feeders above each gin can themselves be provided with a mechanical delivery system by way of a conveyor/distributor which in turn receives cotton from the separator or the inclined cleaner; this system ensures a steady supply of seed cotton to the gin and will further enhance the throughput, giving an overall increase of about 20% compared with manual operation, as well as saving labour.

Many roller gins in the Sudan already have hopper/feeder units, and a few are equipped with the conveyor/distributor system. Implementation of the proposal for replacement of the older gin stands and for further mechanisation of seed cotton handling, as described in the Section 2.4.1, would result in most roller ginneries, including all those without existing hopper/feeders, having fully mechanised feeding systems, with the requirement for carrying and feeding labour reduced to nil. With a partly mechanised system, in which the seed cotton is delivered to a feeding platform above the gins, the carrying labour is reduced by about two thirds.

2.5.2 Saw Gins

The saw gin has undergone considerable changes since it was invented in 1792 although the basic principle of fibre and seed separation is unaltered. In the earlier years, the ginning industry in the USA concentrated mainly on improving the mechanical efficiency of the saw gin, but since the establishment of the US Cotton Ginning Research Laboratory at Stoneville, Mississippi in 1930, emphasis has moved to combining mechanical efficiency with quality improvements, and there has also been extensive research into the effects of mechanical treatments on grade and fibre characteristics and spinning performance.

The 18 operating saw gin installations have a total of 61 gin stands. The earliest installations were in the Nuba Mountains in the 1920s, the latest being in 1979 at Damazin. 12 gin stands are of Lummus, 12 of Platt/Murray, and the remainder of Murray manufacture. Outputs vary considerably due mainly to design changes over the years. The newer installations generally have the greatest throughputs, as well as more sophisticated control equipment. Table 4.10 (see Section 4.5.1) illustrates the considerable differences in output, which vary from 640 lb (290 kg) to 2 910 lb (1 320 kg) per hour per gin stand.

The long staple varieties cannot be saw ginned. Short/medium staple rain grown and irrigated medium staple varieties are best processed by saw ginning, the higher throughput giving the best economic return when set against power consumption and labour costs per tonne of seed cotton. In terms of labour the saw ginnery requires few people inside the factory, and these are mainly skilled and semi-skilled personnel. The main labour requirement is for feeding the ginnery with seed cotton and for removing bales and seed output.

2.5.3 Gin Operation

The gin stand is the heart of the plant, and maintaining the full capacity of the ginnery depends upon the gin stands being in good condition and in proper adjustment. The quality and potential spinning performance of the ginned lint also depend largely on the condition, adjustment, and proper operation of the gin stands. The gin stand can affect every commonly measured fibre property except fibre strength and micronaire value.

(a) Saw Gins

It is essential therefore that prior to the cotton season the gin stands are stripped down and rebuilt, replacing worn or damaged parts, particularly gin saws and ribs. It is also essential that routine maintenance is carried out frequently, at least once per week. It should be stressed that the modern saw gin plant has been designed primarily to suit conditions in the USA, and few ginneries there exceed annual throughputs in excess of 15 000 bales, while saw gin factories in Africa are frequently producing 60 000 bales and more per season. It is thus all the more important when ginning large scale crops over a five to six month period of continuous production to ensure that thorough weekly maintenance is carried out. The importance of routine maintenance is stressed particularly for saw gin factories, the reason being that if one saw gin stand producing 8 to 10 bales of lint per hour is not operating properly or is shut-down the factory production is seriously reduced.

Thus, on the basis of sound engineering principles, this report recommends a six day ginning week, with the seventh day devoted to cleaning and maintenance. Ginning capacity requirements should be calculated accordingly. 8% reserve

capacity can be provided by operating the ginneries for a 13th shift, in addition to the 12 weekly shifts worked from Saturday to Thursday, by mounting a Friday night shift. This system also provides some rest for the labour during a long ginning season.

(b) Roller Gins

Although a roller gin factory is not affected in the same way as a saw gin factory by failure of a single gin, quantity and quality of output depend on proper maintenance and adjustment of the gins. Therefore, six day working is also recommended for roller gin factories.

2.6 Lint Conveyance, Baling and Storage

2.6.1 Lint Conveyance - Roller Ginneries

Lint conveying in most of the roller gin factories is primitive and labour intensive. The lint drops from the gins on to the floor in front of the gin stands from where it is collected manually and loaded into hand-propelled trolleys running down either central or outer aisles, and delivered to the bale presses where it is manually unloaded onto the "farfara" platform. The farfara platform comprises a slatted floor, through which some dust and foreign matter drops. The lint is usually hand-sprayed with water, while being tossed into the air by the labourers. The spraying is intended to make the lint more easy to bale in the press, and to achieve the desired economic weight per bale. The reliance on labour to perform this task is risky, as poor application can result in patchy wet layers of lint which are susceptible to mildew, with subsequent claims from the spinners, and also in underweight bales which place an unnecessary load on the bale press, resulting in higher power and baling material consumption.

The fully mechanised factories are a typical example of lint conveying systems which can be applied to roller gin installations. Lint conveyor belts run the length of the gin lines, delivering into lint flues at the ends. Suction fans pull the lint to condensors, which in turn deliver a batt of lint by gravity down lint slides to the bale press. The lint flue/fan/condensor system is of the type used in saw gin installations, and ensures an even feed to the semi-auto bale presses.

The installation of complete lint conveyance systems, including condensors and lint slides, is recommended wherever it is practical to do so, that is where a new press is to be installed or an existing press can be adapted to suit and if the existing building can be readily and economically modified to suit the equipment.

The advantages of installing lint conveyance in roller ginneries are the protection of the lint between gin and press from contamination with dust, fly, lubricating oils, etc. and, if a pneumatic system is used to elevate the lint from conveyor belts to the condenser, some extraction of dust and short fibre fly at the condenser. The formation of a lint batt at the condenser and the use of a gravity lint slide enables a humidification system to be installed over the lint slide in the form of easily controlled fine sprays, ensuring even distribution of moisture throughout the bale. This system also permits the use of a wetting agent for raising the moisture content of the lint more effectively.

2.6.2 Lint Conveyance - Saw Ginneries

Saw gin plants are designed for pneumatic removal of lint from the gin to the condenser either by air blast from the gin saw, or by brush assisted doffing and suction from the gin saw. It is an efficient system which allows for the installation of lint cleaners between gin and condenser for use on machine picked cottons, the lint of which still contains trash.

2.6.3 Baling

The baling press is reckoned by many to be the key unit of equipment in the cotton ginnery, as if it breaks down all production comes to a standstill and it is the most costly single item of equipment in the ginnery. The reliability of the baling press has undisputed importance for maintaining ginnery production, but it has little or no bearing upon the quality of the lint baled. A reliable and efficient press should be able to maintain a bale output equivalent to the lint output of the gin installation with some reserve to allow for peak production periods and high lint out-turns.

There are 52 bale press units installed in the operating ginneries. All presses produce a standard density bale of not less than 24 lb/cu.ft. (386 kg/m^3), although one or two of the older presses, particularly in the Nuba Mountains, have difficulty attaining this density due to worn-out pumps. Bale densities of around 20 to 24 lb/cu.ft. are acceptable for international trading and shipping and also for local deliveries. It is not recommended in the short or medium term to change the bale densities to high or super high densities between 30 and 40 lb/cu.ft. The costs of installing such plant (press and hydraulic pump) and the increased operating costs, do not appear to be justified from a marketing/shipping viewpoint.

The oldest press units are the John Shaw/Hydraulic Engineering type. All the SGB ginneries at one time had these presses installed, although today only 8 remain after a programme of replacement which halted in 1980 due to lack of funds. These presses have a limited production capacity of about 12 bales per hour, are labour intensive, and do not lend themselves to modern lint conveying systems. They are very strongly built and have given good service throughout their lives although some are over 50 years old. They would no doubt give further reliable service for many more years but for the problem of spares.

The shortage of spares arises from several reasons :

- the massive construction and relatively low operating speeds result in a very low turnover in replacement parts;
- of the 18 presses operating, no more than four are identical in design; frequent design changes and building of presses to customer's specifications result in lack of interchangeability of spares;
- records of the older presses appear to be no longer available, either from the sites or the makers;
- slow turnover of replacement parts results in slow delivery and high cost of the spares;
- the makers are no longer able to compete in price with those presses made by the gin manufacturers.

To a lesser extent the above problems also exist with the Lindemann presses. The remaining presses should present few problems as far as spares are concerned, and all are compatible with modern lint conveying systems.

2.6.4 Bale Handling

Bale handling is, without exception, manual. Forty-one of the presses in Sudan produce a bale 25" x 39" x 27", which can be "rolled" along the ground and is easily lifted for stacking by labour (400 lb/185 kg weight). The optimum number of bales can be loaded into the Sudan Railways trucks, the dimensions of the bales having been designed for this purpose in the 1920s by the SGB ginneries.

However, such a bale size is an anomaly today, as the world leaders in ginning, the USA, have taken the optimum size of bale to be 20" x 55" at Universal Density of not less than 28 lb cu.ft. (445 kg/m^3) and at not less than 480 lb (218 kg) bale weight. The gin manufacturers have therefore tooled up for mass production of presses of this size, although they do offer 20" x 40" presses as an option. The result is that any other non-standard bale press will have a proportionately higher cost. The "flat" 20" x 40" or 20" x 55" bale is, however, more difficult to move and stack manually. Mechanised systems exist whereby the bale can be mechanically handled from the press to the warehouse, and stacked, although they tend to be over-sophisticated, particularly at the press.

Fork lift trucks adapted to handle multiples of bales (4 or more) using bale clamps, are probably a more familiar sight today in ginnery yards, although serious mechanical problems arise when they are used on unpaved surfaces. As this type of surface is the norm in the Sudan, the rough terrain type of fork lift truck as seen on building sites can prove a viable alternative. It is suggested that a few trucks of this type are introduced initially on a trial basis at the SGB ginneries. The standard fork lift truck is quite adequate for use in warehouses which normally have concrete floors. For ease of maintenance and supply of fuel, diesel powered trucks, suitably fitted with exhaust scrubbers and spark arrestors, are recommended.

2.6.5 Storage

Bale storage is usually in the open at the ginnery sites and depends on regular evacuation to the stores at Port Sudan to avoid congestion around the ginneries and possible rain damage at the onset of the rainy season. Protection from ground damp, termite damage etc., in the open storage areas is minimal, bales usually being stacked directly on the earth, although hardstandings, in the form of masonry infilled platforms or concrete slabs, and stillage, consisting of railway sleepers or small tree trunks, are available in limited amounts at most ginneries.

Covered storage for bales, such as warehouses, has been provided for in the past as part of project designs, e.g. for New Halfa and Rahad, and more recently for SGB under the Agricultural Rehabilitation Programme (ARP) funding. However, in practice such warehouse facilities are never used for bale storage, but are invariably used by the producing corporations for consumables such as fertilizer and foodstuffs such as rice or dura. Tarpaulins are available in limited supply, but usually only appear when bale evacuation has been delayed and the rainy season is imminent.

It is proposed that additional hardstandings should be provided where necessary to ensure that there is sufficient short-term storage for bales of lint. This would not only provide better protection from damp, but would also assist in formalising the stacking and relieving congestion around the ginning factories, which is likely to become worse as production increases. It is also recommended that there should be more systematic use of stillage, particularly towards the end of the ginning season when the risk of rain becomes significant.

2.6.6 Automatic Lint Sampling

It is usual in most cotton producing countries to draw a sample of cotton from the bale as it leaves the baling press. In Sudan the usual practice is to draw samples from bales when they arrive in Port Sudan. This results in unsightly bales having patched wrappings and holes in the sides of the bales.

Automatic sampling equipment is used in the USA and some other producing countries. As these sampling units operate by continuously drawing small quantities of lint from the press feeder as the bale is being formed in the press box, they can only be applied to modern baling press systems with condenser, lint slide and automatic press feeding systems. All major manufacturers of ginning machinery are able to supply automatic cotton sampling equipment either of their own manufacture or as commercially bought out items. In effect an automatic sampler is a miniature packaging unit with the same characteristics as a full size baling press. It is equipped with a feed mechanism, a tramping section and a pressing and packaging unit. The principle of operation is as follows and is typical of all makes of sampler.

Ginned cotton lint is drawn from the lint flue by a fan circulated through the sampling machine and returned to the lint flue. At predetermined intervals a sample of lint is retained in the machine and partially compressed. This interval is governed by an electrical timing device and can be adjusted to give the number of samples that are required throughout the bale depending on the ginning rate. This cycle continues all the time the bale is being ginned. The number of samples taken throughout the bale can be adjusted to meet requirements. Once the bale is completed and the press starts to rotate, a signal is sent to the sampler which puts the machinery into the packaging mode. The completed sample is then ejected automatically into a paper or plastic sleeve which can be pre-marked with consecutive bale number, ginnery name and other relevant information.

The advantages of automatic sampling over the more traditional methods are :

- a true representative sample is produced showing the contents of the whole bale;
- the bale covering is not damaged in any way leaving the bale completely covered and with a neat appearance;
- because there are no cuts in the bale covering there is no loose cotton lint hanging from the bale which could be a fire hazard.

Automatic sampling of cotton does, however, have disadvantages. One is the high initial cost of the equipment; the current cost of an automatic sampler complete with all controls, motors, fans and piping is in the order of US$ 35 000 FOB. Another disadvantage with auto-sampling is that, in practice, the equipment can prove unreliable. It is a well known fact that air currents carrying cotton can easily be affected by such factors as humidity, temperature

and ginning variables and it may be found that a perfectly satisfactory operation is taking place one minute and the next a totally unsatisfactory one caused by these variable factors. It follows that considerable care must be taken in selecting the point for the sample pickup connection and considerable experimentation may be necessary with the piping before a satisfactory arrangement is achieved. In the USA, it is not uncommon to find that automatic sampling machines are taken out of ginning factories where they have been installed.

In view of the difficulties of installation and operation, it is recommended that automatic sampling should not be introduced in the Sudan at this stage, even on a trial basis. The matter could be reconsidered should more reliable equipment become available in the future.

Introduction of automatic sampling would also involve establishing a reliable system for delivering the samples to Port Sudan where cotton classifying takes place.

2.7 Seed Processing, Handling and Storage

2.7.1 Conveyance

Seed conveyance within all ginning factories is fully mechanised. In the older roller ginneries conveyance is generally provided by shaker-trough conveyors which are installed below each line of gins and which deliver to a similar transverse conveyor at the end of the gin lines, and thence to a bagging-off point, or to a scarto recovery plant. This system has few moving parts, and is extremely reliable in operation. There is no need for change, except where the installation cannot cope with the volume of seed produced. One drawback, however, is the relatively large installation space required. This is of no account in the older ginneries, where ample space is available in the large basement areas which formerly housed the line shaft and belts used to drive the gins. In the newer ginneries it is necessary either to provide a purpose-built basement (which can also house the lint conveyors) at increased civil costs, or opt for the modern screw conveyors which take up far less space, and can be set in floor slab ducts. Alignment becomes of prime importance with this latter system, and frequent failures of shaft couplings and bearings are common with screw conveyor systems.

Seed conveyance in the saw gin factories comprises both screw conveyor and pneumatic systems.

Seed conveyance of seed ultimately to be used for planting is best provided by the shaker trough system for the long staple 'black' or naked seed which may suffer damage in a pneumatic blowing system. Saw ginned medium staple white seed intended for planting will accept pneumatic blowing conveyance, but care should be exercised in relation to pipe bends and the air pressure applied.

2.7.2 Scarto Recovery

Scarto reclamation takes place only at roller ginneries and is unique to Egypt and the Sudan. Unginned seed cotton, usually small immature locks, is carried through with cotton seed and separated out at the seed gribble. The scarto seed cotton is then processed in small saw gins, with usually not more than 40 saws. The recovered lint is manually bagged and sold on the local market, while the recovered seed is returned to the bagging point via the gribble.

It is not proposed to alter the present system of scarto recovery at roller ginneries, but many of the existing scarto gins are in poor condition, use an off-standard 8 inch OD saw, and are obsolete. The rate of scarto recovery is often low. It is proposed that the existing gins be replaced by current production models using a saw size common to the larger saw gin installations, i.e. 12 inch OD. Because these would have a higher capacity it would be possible to replace two existing gins with one new gin.

2.7.3 Delinting and Seed Treatment

Delinting is applicable to the seed of medium staple varieties such as Acala. Some controversy has arisen over the question of whether the ginnery is responsible for cleaning seed prior to despatch to an oil mill. There is no contractual requirement for this service which only adds to the ginner's production costs. It is generally accepted that the oil miller would clean and, if necessary, delint the seed received.

Delinting of cotton seed at the ginnery takes place only at the Rahad Corporation site at Fau. Factory Nr 1 was designed to deliver seed for planting directly to a mechanical delinting plant, comprising 12 Murray-Carver saw delinters, a linter baling press, and a seed heat steriliser and chemical pesticide dressing plant. Since installation, several problems have come to light, particularly the lack of seed cleaning equipment (although space for this equipment was provided).

In the case of seed required for planting, it would be advisable to carry out seed cleaning prior to mechanical delinting of 'white' Acala type seed. However, the Food and Agricultural Organisation (FAO) has recently carried out a study in Sudan of the availability of pure planting seed, and their preliminary conclusion is that mechanical delinting is unsuitable for seed to be used for planting, mainly because of the risk of damage to the seed shell coat. FAO has made an engineering feasibility study of alternative delinting methods, mainly those using chemical systems, and has concluded, again on a preliminary basis, that the dilute sulphuric acid system using the centrifuge machine is probably the preferable method, principally because :

- lesser amounts of sulphuric acid and water are used;
- there is virtually no effluent ;
- the system is relatively unsophisticated compared with other acid delinting plants currently available.

Existing seed dressing plants are of the dry powder type. At Fau, the plant is poorly maintained, resulting in excessive loss of pesticide powder to the atmosphere in the building and causing an extreme health hazard. (Mercurial based pesticide powder is still used, although this is now banned in most other countries.)

While proposals are included in this report for upgrading of the existing delinting plant at Fau, it will be necessary to take account of the final recommendations of the FAO study. A seed treatment plant for Acala seed will be required on the Gezira scheme to provide the increasing amount of this type of seed required to be planted; this could be incorporated with the new saw gin

factories. The treatment systems currently in use at SGB for the black seed of long staple varieties should be phased out and replaced with more modern systems using wet dressing plants.

2.7.4 Bagging, Handling and Storage

Cotton seed bagging takes place below seed 'gribbles', rotating drums with perforated screens capable of removing fine trash and seed unginned. Trash removal at the seed gribble is common in the public sector ginneries, but some private sector ginneries allow the trash to fall through and be bagged with the seed. B twill jute sacks are used, which hold up to 120 lb (55 kg) of Acala fuzzy seed and up to 180 lb (82 kg) of Barakat black seed.

Weighing is carried out on yardarm type platform scales in all cases, but is very much a casual affair. Accurate weighing is carried out, at best, on a random basis which is the standard method throughout the ginning industry. Policy appears to be to fill the sacks as full as possible. Sacks are sewn over with jute twine.

After sewing, the sacks are moved a short distance from the bagging room either by head load, or hand trolleys, to be stacked prior to distribution to the main storage areas. Tractor and trailers units are sometimes used, but the larger sites, such as the SGB, use contractors' road vehicle trucks. Multiple handling of the cotton seed sacks is common.

Stillage is not used to protect the sacks of seed, as the assumption is that the seed will rapidly be evacuated to the oil mills once the allocations have been determined. The allocation system is the only fair way of ensuring that the over-capacity in the oil mill sector can be fairly met. However, the uncertainty over the past years regarding the annual cotton crop has led to the allocating being delayed until well into the ginning season, until the authorities responsible can determine how much seed will be available for distribution. This is undoubtedly the reason behind the multiple handling practised today at the ginnery sites.

To formalise the storage of cotton seed and relieve congestion, it is recommended that hardstandings should be provided, as for lint bales. The introduction of conveyor/elevators would assist in stacking the heavy bags into 'pyramids' and reduce the space requirements.

Arrangements for the weighing of cotton seed could be greatly improved by the provision of road weighbridges, at least at the larger ginnery sites.

2.8 Lugatta Recovery

Lugatta is the term applied to seed cotton which has dropped out of bags in the stacking area or while being transported to the ginnery and which is gathered up and put through a cleaning system separate from the standard ginnery cleaning unit. This recovered seed cotton after cleaning can then be ginned. The lint which is low grade and frequently discoloured, sells at a lower price, but there is a market for all that is produced.

It is recommended that lugatta cleaning machinery should be provided at ginneries which are not already so equipped, and that existing machinery should be replaced where it is in poor condition. It is necessary to have a separate lugatta cleaning plant in addition to the ginnery cleaning equipment as the lugatta seed cotton is regraded after cleaning.

2.9 Processing of Machine Harvested Cotton

At present all but a small percentage of Sudanese cotton production is hand picked and therefore the trash content is low by comparison with mechanically harvested or hand snapped cotton. Trash contents are best expressed as a percentage of the total weight of cotton plus trash together. Typical average trash contents, applicable to Sudanese conditions, for the various methods are as follows :

Good hand picked	2 %
Rough hand picked	7 %
Hand snapped	17 %
Spindle machine picked	20 %
Machine stripped	47 %

The value quoted above for spindle machine picked cotton is considerably higher than the minimum value which can be achieved by this method due to the fact that the varieties grown in Sudan are not properly suited to machine picking.

Because of its higher trash content, machine harvested cotton requires additional cleaning facilities at the ginnery. If dry, the cotton requires to pass through two inclined cleaners and a stick/greenleaf machine before ginning. (Even after the application of wetting and lubricating agents used in machine harvesting, the seed cotton in Sudan is usually presented to the ginnery at below optimum moisture content (7%), and no artificial drying is required.) In addition the lint should be passed through a lint cleaning machine before pressing. The additional machines can readily be installed into a saw gin factory.

The longer that hand picking can continue in Sudan the better, and the use of mechanical pickers should be delayed as long as possible. Much of the world production of cotton is mechanically harvested and the volume of hand picked cotton is declining. It is not surprising that the lint obtained from hand picked cotton will fetch a premium over machine picked cotton, as it is inherently cleaner, and suffers less machining and processing between field and spinning mill. Nevertheless, there are already some mechanical harvesters in the country of both the spindle picking and stripper types, and it is necessary to consider that in future the use of machine harvesting will increase for medium and short staple cotton.

Mechanical harvesting was introduced on a large scale into Sudan on the Rahad scheme in 1978. It is believed that over 70 machines from some of the principal makers were procured for evaluation purposes, and that trials are still continuing. The Rahad Corporation research farms appear to utilise the machines on a regular basis. All the machines are spindle pickers.

Factory Nr 1 at Fau was equipped with the extra seed cotton pre-cleaning machinery necessary to extract the higher trash content of spindle picked cotton (as opposed to the traditionally clean hand picked seed cotton), and with single stage unit lint cleaners at each gin stand. Factories 2, 3 and 4 were designed with adequate space for the later installation of the seed cotton pre-cleaners, but were provided at the outset with lint cleaners. Seed cotton cleaning equipment identical to that installed in factory Nr 1 has now been purchased under ARP funding for installation in factories 2, 3 and 4. The saw ginnery installation at Damazin, identical in all respects to factories 2, 3 and 4 at Fau, will also be equipped with extra seed cotton pre-cleaning machinery as at Fau.

These then, will be the only ginneries equipped to process spindle picked seed cotton and produce a bale of lint comparable with that produced from clean hand picked cotton. This, of course, is provided that the machinery is in good working order. However, the experience with the lint cleaners at Fau has not been encouraging and the Rahad management considers them to be unworkable. Indeed, since commissioning in 1978/79, when they were operated, with difficulty, during proving trials, they have probably not been operated at all. It was noted that all the lint cleaners had been cannibalised by the removal of belts, bearings and motors. The rusty saw rolls indicated lack of use and the condenser vane-axial fans have been without drive belts and motors for some years. The in-line filters were removed almost immediately after commissioning due to back pressure caused by screen blockages (stickiness from honeydew).

It must be stressed that there is overwhelming evidence from the ginning industry in the USA that machine harvested cotton must be processed using lint cleaners to obtain the best market value for the lint.

The team made efforts, without success, to trace bales produced from spindle picked seed cotton. It appears that there has been no co-ordinated attempt to determine :

- the cost of mechanically harvesting seed cotton;
- the cost of processing the machine harvested seed cotton, given the extra power requirements within the ginneries;
- the final grades and value of the bales of lint produced;
- the reaction of traders and spinners to Sudanese bales produced from mechanically harvested cotton.

A further complication is the recent introduction of some 27 stripper harvesters, intended for the Mechanised Farming Corporation cotton farm at Damazin. It is understood that some of these machines have been transferred to other producing corporations for trials. It is considered, however, that none of the existing ginneries is equipped to adequately clean seed cotton harvested by stripper machinery, which has a far higher trash content than spindle machine picked cotton and requires additional stages of both seed cotton and lint cleaning.

It is clear that careful consideration must be given to the question of machine harvesting in relation to ginning, and that there must be proper coordination between the harvesting and processing sectors to avoid wasted expenditure.

CHAPTER 3

PROPOSED INVESTMENTS AT EXISTING GINNING FACTORIES

3.1 Introduction

3.1.1 General

This chapter provides details of the proposed investments at each of the existing ginning factories, covering mechanical and electrical installations and associated factory buildings and civil works.

Proposals for improvements in ginning facilities are made on the basis of the recommendations given in the previous chapter. Investments in rehabilitation include such items as:

- replacement of worn-out or obsolete equipment;
- overhaul of existing equipment;
- provision of an adequate stock of spare parts.

The private sector ginneries present some problem where rehabilitation or modernisation is concerned, mainly due to lack of enthusiasm on the part of the owners to any further investment. In view of this, proposed investments have been kept to a minimum, although it may be argued that what applies to the public sector in the way of expensive improvements intended to raise the quality of the lint should also apply to the private sector.

Existing ginnery buildings (which are, with few exceptions, of steel frame construction with GCI sheeting on walls and roofs and with concrete floors) are generally in good condition and well suited to their function. However, remedial works and minor improvements are required at some factories. In addition, new buildings will be required in connection with some of the proposed improvements in ginning facilities.

Details of investments in factory electrical installations are given at the end of this chapter, in Section 3.12.

A summary of the main proposed rehabilitation works and improvements at each factory is shown in Figure 3.1. Composite tables showing all the investments proposed at each site are given in Annex 8 - Economic and Financial Analysis, and summaries of costs by ginnery are also included in the Main Report.

3.1.2 Basis of Cost Estimates

All costs for mechanical plant and equipment are based on quotations obtained from manufacturers. A standard allowance of 12% has been added to the FOB price to cover the costs of insurance and freight and any foreign exchange costs of installation such as attendance of manufacturers' installation engineers. A further allowance has been made to cover the local currency costs of handling and installation over and above the costs of any specific associated civil works. Cost estimates for civil and building works are generally based on the unit rates given in Chapter 5.

3.2 Sudan Gezira Board Ginneries

3.2.1 Gezira Rehabilitation Project

The SGB ginneries were studied by Euroconsult as part of the Gezira Rehabilitation Project. The recommendations made in the Final Report (1982) can be summarised as follows:

(a) Three mechanised factories, Nrs 11, 12 and 14, should be fitted with pre-cleaning and humidification equipment.

(b) Factories 4, 5 and 6 should be fully mechanised in the seed cotton and lint handling sections and seed cotton cleaning and humidification equipment should be installed. These three factories are the most modern of the nine remaining labour-intensive factories, in that they have both Model 2 gins and 2 modern semi-automatic bale presses per factory (1 in each wing) which make the mechanisation of the lint conveying section particularly feasible.

(c) The seed-dressing plant at Factory Nr 10 should be re-equipped, and a new seed-dressing plant attached to Factory Nr 11.

(d) Trials for a high capacity roller gin (HCRG) plant should be instituted and, if successful, two HCRG factories would be built.

Following the project appraisal by the IDA, the first three recommendations have been accepted for implementation under the GRP. However, in place of the HCRG plants, it is proposed to construct two new saw gin factories at Marangan, each with a capacity of 20 bales/hour (equivalent to about 250 tonnes of seed cotton per day). Financing for the ginning component of the GRP is to be provided by the Arab fund. As discussed in Chapter 2, it is suggested that a seed cotton moduling system should be incorporated into the design of these plants. Apart from the handling advantages, considerably improved blending could be expected, although this is not as important for Acala medium staple cotton as for Barakat long staple cotton.

Other items proposed under the GRP include improvements in ginning infrastructure (see Chapter 5) and the provision of yard handling equipment.

It is noted that the GRP proposals do not include construction of a seed treatment plant for Acala seed. Such a plant, which is considered necessary in view of the expanding production of Acala cotton, should preferably be attached to a new saw gin factory.

3.2.2 Project Proposals

With the above in mind, the recommendations of the present study are as follows:

(i) The programme of factory modernisation and mechanisation should be extended to cover the remaining six labour-intensive factories.

Factories 1, 2 and 3 (Marangan) should be fully mechanised using systems similar to those already installed in Factories 11, 12 and 14. This would include replacement of the existing manually

Ginnery		Gin stands Nr	Gin stands Type	S/C blending	Pneumatic/mech s/c conveying & feeding	S/C cleaning	Pneumatic/mech s/c conveying	Elevated s/c feeding platform	Humidification	Gin stands	Lint conveying	L
Marangan	Nr 1	92	R	+	+	+			●		+	
Marangan	Nr 2	92	R	+	+	+			●		+	
Marangan	Nr 3	92	R	+	+	+			●		+	
Marangan	Nr 4	92	R	+	*	*			*		*	
Marangan	Nr 11	92	R	+		*			*			
Hasaheisa	Nr 5	92	R	+	*	*			*		*	
Hasaheisa	Nr 6	92	R	+	*	*			*		*	
Hasaheisa	Nr 7	92	R	+	+	+			●	■	+	
Hasaheisa	Nr 8	92	R	+	+	+			●	■	+	
Hasaheisa	Nr 10	20	R						●			
Hasaheisa	Nr 12	92	R	+		*			*			
Hasaheisa	Nr 13	46	R	+	+	+			●	■	+	
Bageir	Nr 14	100	R	+		*			*			
Sennar		60	R			+	+	+	●			
Hamadnallah		68	R			+	X	+			+	
Kassab	Nr 1	65	R	+	■	+			■	■	+	
Kassab	Nr 2	3	S						+			
Kassab	Nr 3	3	S		O							
Dueim		48	R			+	X	+	●		+	
Kosti		48	R			+	X	+	●		+	
Rabak		100	R	+	+	+			■	■	+	
Fau	Nr 1	3	S		O							O
Fau	Nr 2	3	S		O							O
Fau	Nr 3	3	S		O							O
Fau	Nr 4	3	S		O							O
New Halfa	Nr 1	3	S		X				+			
New Halfa	Nr 2	3	S		X				+			
New Halfa	Nr 3	3	S		X				+			
Zeidab		40	R									
Port Sudan		80	R									
Kadugli		4	S						+			
Talodi		3	S						+			
Kologi		4	S						+			
Abu Gebeiha		4	S						+			
Umm Berembeita		4	S						+	●		
Semeih		4	S						+	●		
Dilling		4	S						+	●		
Lagowa		4	S						+			
Damazin		3	S									

Key : Improvements : + Add new equipment/facilities ■ Replace exis

Rehabilitation : ● Replace existing equipment O Overhaul/re

* Improvements proposed under Gezira Rehabilitation Project

Summary of Proposed Works at Ginneries

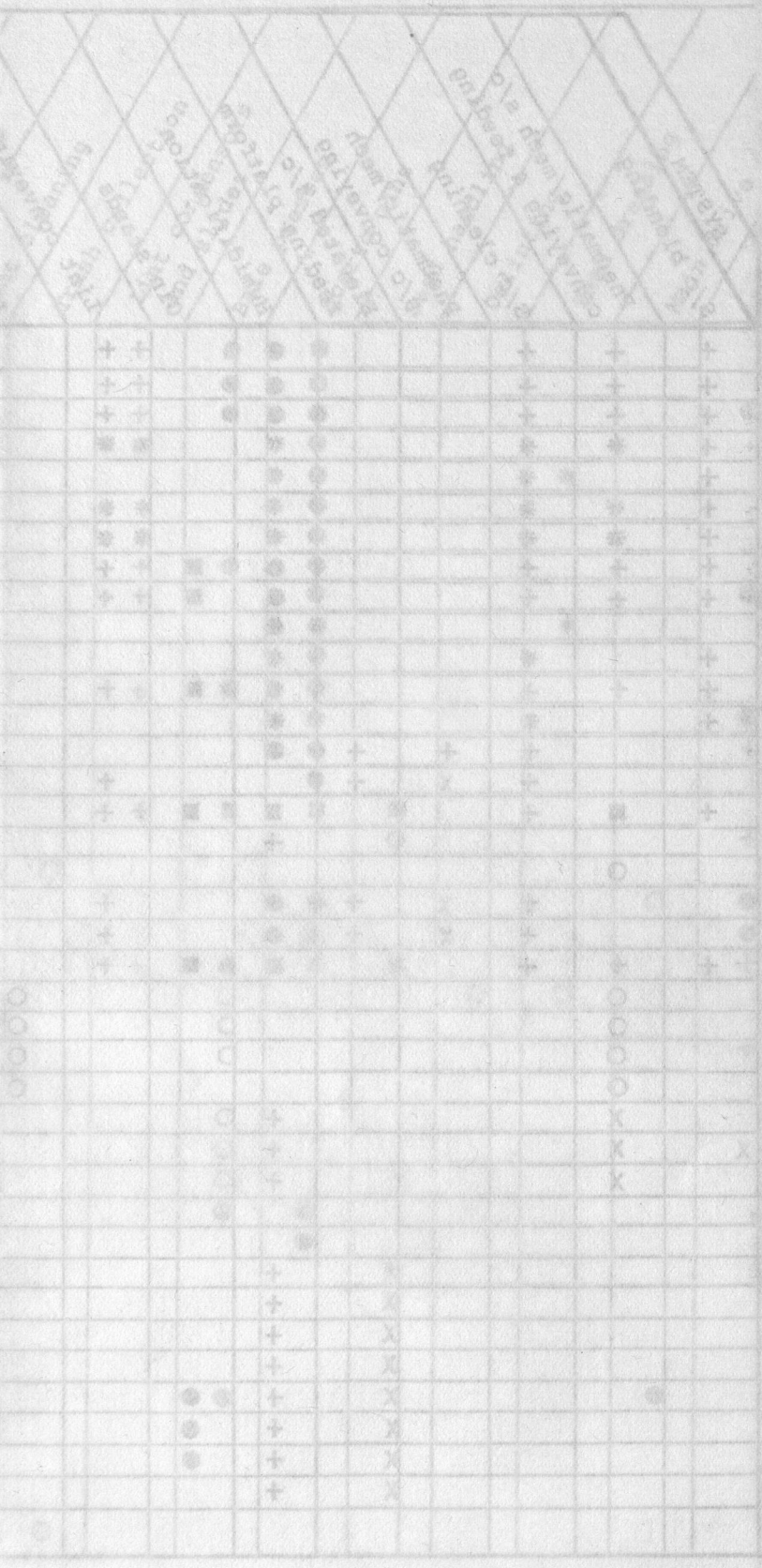
Ginnery	Gin stands Nr	Gin stands Type	SYSTEM	S/c blending	Pneumatic/mech s/c conveying & feeding	S/c cleaning	Pneumatic/mech s/c conveying	Elevated s/c feeding platform	Humidification	Gin stands	Lint conveying	Lint cleaning	Trash collection	Lint condensors and slides	Bale presses	Scarto gins	Seed handling	Delinting	Seed dressing	Main drive engine	Lugatta cleaning	Yard equipment	Roads and hardstandings	Weighbridge	Workshop	Power supply
Marangan Nr 1	92	R		+	+	+			●		+			+	●	●										
Marangan Nr 2	92	R		+	+	+			●		+			+	●	●										
Marangan Nr 3	92	R		+	+	+			●		+			+	●	●				●	+/*	+/*	+			
Marangan Nr 4	92	R		+	*	*			*		*			*		●										
Marangan Nr 11	92	R		+		*			*							●			*							
Hasaheisa Nr 5	92	R		+	*	*			*		*			*		●										
Hasaheisa Nr 6	92	R		+	*	*			*		*			*		●										
Hasaheisa Nr 7	92	R		+	+	+			●	■	+			+	●	●										
Hasaheisa Nr 8	92	R		+	+	+			●	■	+			+		●				●	+/*	+/*	+	+		
Hasaheisa Nr 10	20	R							●							●			*							
Hasaheisa Nr 12	92	R		+		*			*							●										
Hasaheisa Nr 13	46	R		+	+	+			●	■	+			+	●	●										
Bageir Nr 14	100	R		+		*			*							●				●	+/*	+/*	+			
Sennar	60	R				+	+	+	●							●				+		+				■
Hamadnallah	68	R				+	x	+			+					●						+				+
Kassab Nr 1	65	R		+	■	+			■	■	+			+	■	■	■									
Kassab Nr 2	3	S							+								O			+	+	+	+			
Kassab Nr 3	3	S			O								O													
Dueim	48	R				+	x	+	●		+					●				●		+				+
Kosti	48	R				+	x	+	●		+					●				●		+				
Rabak	100	R		+	+	+			■	■	+			+	■	■	■				+		+				
Fau Nr 1	3	S			O							O			O			O	O							
Fau Nr 2	3	S			O							O			O											
Fau Nr 3	3	S			O							O			O						+	+	+	+		
Fau Nr 4	3	S			O							O														
New Halfa Nr 1	3	S			X				+						O											
New Halfa Nr 2	3	S			X				+						O						X	+	+	+		+
New Halfa Nr 3	3	S			X				+						O											
Zeidab	40	R													●	●										
Port Sudan	80	R														●					+					
Kadugli	4	S							+								X								+	
Talodi	3	S							+								X								+	
Kologi	4	S							+								X								+	
Abu Gebeiha	4	S							+								X								+	
Umm Berembeita	4	S							+	●					●		X			●					+	
Semeih	4	S							+	●							X								+	
Dilling	4	S							+	●							X								+	
Lagowa	4	S							+								X								+	
Damazin	3	S										O										+				

Key : Improvements : + Add new equipment/facilities ■ Replace existing equipment with equipment of higher capacity × Modify existing equipment

Rehabilitation : ● Replace existing equipment O Overhaul/renovate existing equipment

* Improvements proposed under Gezira Rehabilitation Project

Summary of



operated presses. Each wing of each factory would become a self-contained ginnery unit of 46 gin stands complete with bale press.

Factories 7, 8 and 13 (Hasaheisa) should be stripped of their existing machinery (including mainly Model 1 gins) and re-equipped as fully mechanised 92 gin stand factories (46 gin stands in Factory 13), similar to the type of factories currently being commissioned and handed over to the Egyptian ginning industry, under their rehabilitation programme. The recently installed semi-automatic bale presses in Factory 8 (both wings) and Factory 7 (east wing) would be retained but Factories 7 (west wing) and 13 would each have a single new bale press.

It is worth noting why the recommendation to install the new type of gin does not also apply to Factories 1, 2 and 3. SGB has invested considerable capital in these factories over recent years, with the purchase and installation of Model 2 gins (as also in Factories 4, 5 and 6), and these gins lend themselves to mechanised systems. Such investment cannot be lightly dismissed, and the best use must be made of these gins for the duration of their lives.

(ii) Mechanised seed cotton mixing and blending facilities should be installed at all existing factories except Nr 10. These would take the form of purpose-built blending halls as described in Chapter 2. All the factories apart from Nr 13 have two wings, each with its own bale press, and a separate blending hall would be provided for each wing. As seed cotton is delivered to the ginning factory from the yard on both sides, it is proposed that there would be one blending hall on each side of the factory. With this arrangement, separate 300 bale lots would be produced from each press.

(iii) Inclined cleaners would be installed in Factories 1, 2, 3, 7, 8 and 13 as part of the mechanisation of seed cotton handling.

(iv) New humidification systems should be installed in Factories 1, 2, 3, 7, 8 and 13, and also in Factory 10 which at present has no humidification system.

(v) All scarto gins and lugatta cleaning plants should be replaced.

(vi) Additional tractors for seed cotton transport should be provided (the supply of trailers is included under GRP). A small number of rough terrain grab-lift trucks for bale handling should also be provided for use on a trial basis at selected factories.

(vii) A weighbridge should be installed at each site.

(viii) A carpentry workshop (8 m x 8 m x 4.5 m high) should be provided at Hasaheisa.

The requirements for new equipment and spares and the costs of civil and building works are given in Tables 3.1 to 3.7.

It is also proposed that provision should be made under the Cotton Marketing Project for the construction of an Acala seed treatment plant at Marangan. The cost of this would depend on the type of treatment process adopted (see Chapter 2), but provisional costs are estimated as follows:

	FE cost (US$ '000)	Total cost (LS '000)
Machinery and equipment	672	1 367
Treatment plant building	124	314
Seed store (3 000 m^2)	372	942

3.3 Blue Nile Ginneries

3.3.1 Sennar Ginnery (Private)

The proposed new equipment and spares requirements are listed in Tables 3.8 and 3.9, and the costs of civil and building works are given in Table 3.10.

(i) The addition of seed cotton cleaning equipment is recommended.

(ii) It is proposed that the existing pneumatic seed cotton delivery system, which is currently out of use, be improved by the addition of a screw conveyor system below the air separators, and that the seed cotton be distributed along an elevated platform (to be constructed) from which the seed cotton may be fed by hand into the gin stands. Advantages of this proposed system are that feeding labour is reduced from one per three gin stands to one per six gin stands, and that the gin feeder/hoppers can be easily seen from above and topped up when required, thus improving throughput. At present, the feeding labour find it difficult to watch all the gin stand feeder/hoppers, and quite often several gin stands operate empty.

(iii) A humidification system similar to that existing at Hamadnallah should be installed.

(iv) The factory is at present not fully electrified, 49 of the 60 gins still being driven by a central lineshaft. Electrification of the factory should be completed by the addition of electric drives to these gin stands. (This will also require an increase in the power supply capacity - see Chapter 6.)

(v) The scarto gin stands should be replaced.

(vi) A lugatta cleaning plant should be provided.

Two further points should be noted:

- A locally made lint conveyor installed at floor level carries the lint to the bale platform. Loading on to the conveyor from the gin stands is manual. This system operates satisfactorily and no change is proposed.

TABLE 3.1

Sudan Gezira Board - Marangan Ginnery
Costs of New Equipment

	Item	Class[1]	Unit FE cost (US $'000)	Number required	FE cost (US $'000)	Total cost[2] (LS '000)
1.	Weighbridge, 50 t x 3 m x 18 m	I	35	1	35	71
2.	Seed cotton conveyors	I	383	3	1 149	2 487
	Separators and associated piping	I	123	3	370	800
	Inclined cleaners - 2 per factory	I	38	6	228	492
	Feed control units	I	50	3	151	325
	Overflow pen and live overflow system - Factories 1, 2, 3	I	86	3	259	561
3.	Lint conveyors, condensors, lint slides - Factories 1, 2, 3 - 2 units per factory	I	129	6	773	1 674
4.	Humidification systems - Factories 1, 2, 3	R	112	3	336	683
5.	Bale presses, 25 in. x 39 in. standard density - Factories 1, 2, 3 - 2 per factory	R	319	6	1 915	3 897
6.	Seed cotton blending hall conveying equipment - Factories 1, 2, 3, 4, 11 - 2 units per factory	I	138	10	1 380	2 800
7.	Lugatta cleaning plant	R	77	1	77	157
8.	Scarto gin stands	R	18	10	179	364
9.	Tractors, seed cotton transport in yard	I	18	15	269	605
10.	Rough terrain grab-lift trucks for bale handling[3]	I	29	6	175	39.1

Notes: (1) I - Improvement; R - Rehabilitation.
(2) Excluding civil and building costs.
(3) For trial use at all SGB ginneries.

TABLE 3.2

Sudan Gezira Board - Marangan Ginnery
Costs of Factory Buildings and Civil Works

	Item	Class	FE cost (US $'000)	Total cost (LS '000)
1.	Weighbridge civil works and office	I	8	25
2.	Civil works for modernisation - Factories 1, 2, 3	I	93	301
3.	Press pits - Factories 1, 2, 3 (6 Nr)	R	37	120
4.	Blending hall buildings - Factories 1, 2, 3, 4, 11 (10 Nr)	I	530	1 350
5.	Lugatta cleaning plant building	R	14	37

TABLE 3.3

Sudan Gezira Board - Hasaheisa Ginnery
Costs of New Equipment

	Item	Class[1]	Unit FE cost (US$ 1 000)	Number required	FE cost (US$ '000)	Total cost[2] (LS '000)
1.	Weighbridge, 50 t x 3 m x 18 m	I	35	1	35	71
2.	Seed cotton conveyors	I	383	2.5	958	2 074
	Separators and associated piping	I	123	2.5	308	666
	Inclined cleaners	I	38	5	190	410
	Feed control units	I	50	2.5	126	272
	Overflow pen and live overflow system - Factories 7, 8, 13	I	86	2.5	216	468
3.	Gin stands and feeders - Factories 7, 8, 13	I	13.4	230	3 090	6 288
4.	Distributor/feeder units - Factories 7, 8, 13	I	441	2.5	1 235	2 692
5.	Lint conveyors, condensors, lint slides - Factories 7, 8, 13 - 2 units per factory	I	129	5	644	1 392
6.	Bale presses, 25 in. x 39 in. x standard density - Factories 7, 13	R	319	2	638	1 298
7.	Humidification systems - Factories 7, 8, 10, 13	R	112	3[3]	336	683
8.	Seed cotton blending hall conveying equipment - Factories 5, 6, 7, 8, 12, 13	I	138	11	1 518	3 080
9.	Lugatta cleaning plant	R	77	1	77	157
10.	Scarto gin stands	R	18	12	215	438
11.	Tractors, seed cotton transport in yard	I	18	14	251	568

Notes : (1) I - Improvement
R - Rehabilitation
(2) Excluding civil and building costs.
(3) Equivalent of 1 unit for factories 10 and 13.

TABLE 3.4

Sudan Gezira Board - Hasaheisa Ginnery
Costs of Factory Buildings and Civil Works

	Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1.	Weighbridge civil works and office	I	8	25
2.	Civil works for modernisation - Factories 7, 8, 13	I	93	301
3.	Press pits - Factories 7, 13 (2 Nr)	R	25	81
4.	Blending hall buildings - Factories 5, 6, 7, 8, 12, 13 (11 Nr)	I	583	1 485
5.	Lugatta cleaning plant building	R	14	37
6.	Carpentry workshop	R	7	18

TABLE 3.5

Sudan Gezira Board - Bageir Ginnery
Costs of New Equipment

	Item	Class(1)	Unit FE cost (US$ '000)	Number required	FE cost (US$ '000)	Total cost(2) (LS '000)
1.	Weighbridge, 50 t x 3 m x 18 m	I	35	1	35	71
2.	Seed cotton blending hall conveying equipment	I	138	2	276	560
3.	Lugatta cleaning plant	R	77	1	77	157
4.	Scarto gin stands	R	18	2	36	74
5.	Tractors, seed cotton transport in yard	I	18	4	72	163

Notes: (1) I - Improvement
R - Rehabilitation
(2) Excluding civil and building costs.

TABLE 3.6

Sudan Gezira Board - Bageir Ginnery
Costs of Factory Buildings and Civil Works

	Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1.	Weighbridge civil works and office	I	8	25
2.	Blending hall buildings (2 Nr)	I	106	270
3.	Lugatta cleaning plant building	R	14	37

TABLE 3.7

Sudan Gezira Board - All Ginneries
Costs of Spares

	Item	FE cost (US$ '000)	Total cost (LS '000)
1.	Platt gin spares	876.8	1 698
2.	Lummus press spares	576.3	1 115
3.	Murray press spares, Factory Nr 10	49.5	96
4.	Perforated steel sheet and brass	10.6	19
5.	Gear boxes	2.7	6
6.	Packing, press pumpsets	2.6	6
7.	Belting, Gandy belts	2.7	5
8.	V belts	130.0	225
9.	Double V and flat belts	199.5	345
10.	Hand and workshop tools	17.4	33

TABLE 3.8

Blue Nile - Sennar Ginnery
Costs of New Equipment

	Item	Class[1]	Unit FE cost (US$ '000)	Number required	FE cost (US$ '000)	Total cost[2] (LS '000)
1.	Inclined cleaners	I	38	2	76	155
2.	Conveyor distributors	I	101	1	101	205
3.	Humidification system	R	112	1	112	228
4.	Lugatta cleaning plant	I	77	1	77	157
5.	Electric drives	I	0.17	49	8	18
6.	Scarto gin stands	R	18	1	18	39

Notes: (1) I - Improvement
R - Rehabilitation

(2) Excluding civil and building costs.

TABLE 3.9

Blue Nile - Sennar Ginnery
Costs of Factory Buildings and Civil Works

	Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1.	Civil works for cleaners	I	13	41
2.	Raised platform for s/c feeding	I	24	59
3.	Lugatta cleaning plant building	I	14	37

TABLE 3.10

Blue Nile - Sennar Ginnery
Costs of Spares

	Item	FE cost (US$ '000)	Total cost (LS '000)
1.	Ruston main engine spares	66	128
2.	Bale press spares	31	60
3.	Gin stand spares	22	43
4.	Workshop tools and equipment	11	21

- The bale press is an obsolete John Shaw model, and ideally should be replaced by a new semi-automatic type. However, an investment in excess of $ 300 000 is unlikely to meet with approval from the owners. The modernisation of the older public sector ginneries should provide some spares to keep the press operational for some years to come.

3.3.2 Hamadnallah Ginnery (Private)

The recommendations for this ginnery are similar to those for Sennar, as follows:

(i) Seed cotton cleaning equipment should be added.

(ii) It is proposed that the existing pneumatic seed cotton delivery system (operational) be raised, and a feeding platform built, for the same reasons as outlined above for Sennar.

(iii) The existing humidification system should be brought back into use (and used as a model for other roller ginneries).

(iv) A lint conveying system similar to that at Sennar ginnery should be installed.

(v) The scarto gin stands should be replaced.

The costs of these proposals are detailed in Tables 3.11 to 3.13.

It is also recommended that an NEC power supply should be provided (see Chapter 6).

3.4 Kassab Ginnery

The works proposed at individual factories are as follows:

(a) Factory Nr 1

This ginnery was transferred from another site, and the machinery is already extremely old. It is recommended that the machinery be stripped out and a plant similar to that proposed for SGB Factories 7 and 8 be installed. This would have 68 gin stands, compared with 65 at present, and a single bale press. A seed cotton blending hall should also be provided.

(b) Factory Nr 2

This is an older type of saw gin plant, but well maintained and in good operating order. The prime mover, a direct drive diesel engine, was removed some years ago, and never replaced. The plant has remained idle since. Plans and proformas have been drawn up to electrify the plant, and it is understood that these plans will be implemented under ARP funding.

It is recommended that a humidification system should be installed, and a building (10 m x 10 m) constructed to enclose the seed hopper.

TABLE 3.11

Blue Nile - Hamadnallah Ginnery
Costs of New Equipment

	Item	Class(1)	Unit FE cost (US$ '000)	Number required	FE cost (US$ '000)	Total cost(2) (LS '000)
1.	Separator/vacuum wheel	I	28	1	28	57
2.	Inclined cleaners	I	38	1	38	77
3.	Suction fan	I	6	1	6	12
4.	Lint conveyor belts	I	129	1	129	261
5.	Scarto gin stands	R	18	1	18	39

Notes: (1) I - Improvement
R - Rehabilitation

(2) Excluding civil and building costs.

TABLE 3.12

Blue Nile - Hamadnallah Ginnery
Costs of Factory Buildings and Civil Works

	Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1.	Civil works for cleaners	I	13	41
2.	Raised platform for s/c feeding	I	24	59

TABLE 3.13

Blue Nile - Hamadnallah Ginnery
Costs of Spares

	Item	FE cost (US$ '000)	Total cost (LS '000)
1.	Ruston main engine (1 Nr)	77	148
2.	Ruston auxiliary engines (4 Nr)	125	242
3.	John Shaw pumps and presses	31	60
4.	Gin stand spares	22	43
5.	Workshop tools and equipment	11	21

(c) Factory Nr 3

No investment is required here for improvements, but badly worn piping in the pneumatic seed cotton and trash conveying systems requires to be replaced. It is recommended that this should be done using heavy gauge piping with flanged connections rather than the light gauge galvanised piping used at present. The trash cyclones also require renovation.

Should mechanised harvested seed cotton be presented to this factory, it will require the installation of the correct type of seed cotton pre-cleaning machinery, depending on the harvesting method, and the rebuilding of the existing lint cleaners, which have been cannibalised. Space for the installation of additional cleaning equipment is available.

The following general improvements are also proposed:

(i) Roller conveyors should be provided at the two saw gin factories to assist in feeding seed cotton into the mixing rooms.

(ii) A lugatta cleaning plant should be provided.

(iii) A weighbridge should be installed.

The costs of new equipment, spares and factory civil and building works are shown in Tables 3.14 to 3.16.

3.5 White Nile Ginneries

3.5.1 Dueim and Kosti Ginneries (Private)

The same recommendations apply to both ginneries, as follows :

(i) Seed cotton cleaning equipment should be added.

(ii) The existing pneumatic seed cotton conveying system should be raised and a seed cotton feeding platform constructed.

(iii) A locally made lint conveying system should be installed.

(iv) A humidification system similar to that at Hamadnallah should be provided.

(v) The scarto gin stands should be replaced.

(vi) A lugatta cleaning plant should be provided.

Details of costs are given in Tables 3.17 to 3.19 (Dueim) and Tables 3.20 to 3.22 (Kosti).

Dueim ginnery should be connected to the NEC power supply when the planned HV power line from Rabak reaches the Dueim area (see Chapter 6).

TABLE 3.14

Suki Corporation - Kassab Ginnery
Costs of New Equipment

	Item	Class[1]	Unit FE cost (US$ '000)	Number required	FE cost (US$ '000)	Total cost[2] (LS '000)
	Factory Nr 1					
1.	Gin stands and feeders	I	11.8	68	800	1 720
2.	Lint conveyors, condensor and lint slide	I	129	1	129	277
3.	Bale press	I	318	1	318	643
4.	Seed cotton blending hall conveying equipment	I	138	1	138	280
5.	Modify seed cotton elevators and suction pipes	I	22	1	22	48
6.	Separator/vacuum wheel	I	28	2	56	120
7.	Inclined cleaners	I	38	2	76	164
8.	Humidification system	I	112	1	112	241
9.	Scarto gin stand	I	18	1	18	39
10.	Seed handling system	I	90	1	90	192
11.	Seed gribble (4 t/hr)	I	56	1	56	120
	Factory Nr 2					
12.	Humidification system (seed cotton and lint)	I	55	1	55	112
13.	Modify tramper drive	R	7	1	7	14
14.	Cottonseed blower	R	6	1	6	12
15.	Piping	R	6	1	6	12
	Factory Nr 3					
16.	Pipework and trunking	R	56	1	56	113
17.	Renovate and improve trash cyclones	R	56	1	56	113
	General					
18.	Weighbridge (50 t x 3 m x 18 m)	I	35	1	35	71
19.	Conveyors for bagged seed cotton	I	11	3	22	45
20	Lugatta cleaning plant	I	77	1	77	157

Notes: (1) I - Improved
R - Rehabilitation
(2) Excluding civil and building costs.

TABLE 3.15

Suki Corporation - Kassab Ginnery
Costs of Factory Buildings and Civil Works

	Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1.	Weighbridge civil works and office	I	8	25
2.	Civil works for modernisation - Factory Nr 1	I	31	100
3.	Re-lay floor - Factory Nr 1	I	24	78
4.	Press pit - Factory Nr 1	I	13	41
5.	Blending hall building - Factory Nr 1	I	53	135
6.	Seed hopper building - Factory Nr 2	R	9	32
7.	Lugatta cleaning plant building	I	14	37

TABLE 3.16

Suki Corporation - Kassab Ginnery
Costs of Spares

	Item	FE cost (US$ '000)	Total cost (LS '000)
1.	Factory Nr 1 - short term spares	50	97
2.	Factory Nr 2 - gin and press spares	84	162
3.	Factory Nr 3 - gin and press spares	84	162
4.	Workshop tools and equipment	56	108

TABLE 3.17

White Nile - Dueim Ginnery
Costs of New Equipment

	Item	Class[1]	Unit FE cost (US$ '000)	Number required	FE cost (US$'000)	Total cost[2] (LS '000)
1.	Humidification system	R	112	1	112	228
2.	Lugatta cleaning plant	R	77	1	77	157
3.	Lint conveyor	I	129	1	129	262
4.	Inclined cleaner	I	38	1	38	77
5.	Separator/vacuum wheel	I	28	1	28	56
6.	Suction fan	I	6	1	6	12
7.	Scarto gin stand	R	18	1	18	39

Notes : (1) I - Improvement
R - Rehabilitation
(2) Excluding civil and building costs.

TABLE 3.18

White Nile - Dueim Ginnery
Costs of Factory Buildings and Civil Works

	Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1.	Civil works for cleaner	I	13	41
2.	Raised platform for s/c feeding	I	24	59
3.	Lugatta cleaning plant building	R	14	37

TABLE 3.19

White Nile - Dueim Ginnery
Costs of Spares

	Item	FE cost (US$ '000)	Total cost (LS '000)
1.	Ruston main engines (4 Nr), including complete overhaul Nr 1 and 2 engines	251	485
2.	Bale press spares	31	60
3.	Workshop tools and equipment	11	21

TABLE 3.20

White Nile - Kosti Ginnery
Costs of New Equipment

Item	Class[1]	Unit FE cost (US$ '000)	Number required	FE cost (US$ '000)	Total cost[2] (LS '000)
1. Humidification system	R	112	1	112	228
2. Lugatta cleaning plant	R	77	1	77	157
3. Lint conveyor	I	129	1	129	262
4. Inclined cleaner	I	38	1	38	77
5. Separator/vacuum wheel	I	28	1	28	56
6. Suction fan	I	6	1	6	12
7. Scarto gin stand	R	18	1	18	39

Notes : (1) I - Improvement
R - Rehabilitation
(2) Excluding civil and building costs.

TABLE 3.21

White Nile - Kosti Ginnery
Costs of Factory Buildings and Civil works

Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1. Civil works for cleaner	I	13	41
2. Raised platform for s/c feeding	I	24	59
3. Lugatta cleaning plant building	R	14	37

TABLE 3.22

White Nile - Kosti Ginnery
Costs of Spares

Item	FE cost (US$ '000)	Total cost (LS '000)
1. Ruston main engines (2 Nr)	153	295
2. Bale press spares	31	60
3. Workshop tools and equipment	11	21

3.5.2 Rabak Ginnery

This ginnery was established in 1954 under private ownership, but over the last 15 years it has suffered several changes of ownership, with periods of operation by both SGB and CPC. The machinery is unique in that it is all of German origin, of a type not found elsewhere in the Sudan. Enquiries to the manufacturers have established that they are unable to supply or design any form of mechanised seed cotton or lint conveying systems to suit the machinery.

It is therefore proposed that all the existing machinery be removed, and a new ginning system similar to that proposed for SGB Factories 7 and 8 should be installed. There would be 92 new gin stands, in place of the 100 existing gins, and it is proposed that the factory should have a single new bale press fed by all the gins. Two blending halls would be constructed. The required equipment is listed in Table 3.23, and the costs of buildings and civil works are given in Table 3.24.

Rabak is the most heavily staffed of the existing ginning factories, and benefits of modernisation in terms of labour saving would be considerable. Modernisation should also lead to renewed enthusiasm amongst ginnery management and operating staff, who appear to have become demoralised over the years as a result of the frequent changes of operator.

3.6 Fau Ginnery

3.6.1 General

The Fau ginnery is a relatively new installation (completed in 1978) and no major investment in new plant at the existing factories is proposed, apart from modifications to the delinting plant (described in Section 3.6.2). However, because of the faster than planned increase in cotton production, and pressure from management to gin out the crop as quickly as possible, maintenance has been badly neglected and much of the machinery is in poor condition for its age. The proposed fifth factory (see Chapter 4) should take the pressure off the existing factories and allow planned maintenance and a six-day week to be instituted. Without regular maintenance, further serious deterioration of the equipment can be expected, with a consequent decline in output.

The following particular points should be noted :

(a) The casings on the most of suction fans on the seed cotton conveyance and cleaning systems are badly worn and holed, resulting in dust and trash escaping to the gin hall atmosphere. The casings should be replaced with heavy duty segments.

(b) The auto gin breast throwouts have been removed, feed control to the gins being carried out manually.

(c) Major overhaul of the bale presses in Factories 1, 2 and 3 is urgently required. These are in particularly poor condition; they should be completely stripped down so that the required spares can be identified and replaced as a matter of priority. Unless this is done, it is unlikely that these presses will be able to process another two seasons' crops. Already, during the 1982/83 season, 4 side columns on Nr 1 press have broken, due

TABLE 3.23

White Nile - Rabak Ginnery
Costs of New Equipment (US$ '000)

	Item	Unit FE cost (US$ '000)	Number required	FE cost (US$'000)	Total cost(2) (LS '000)
	Complete New Roller Gin Installation				
1.	Seed cotton handling system from suction telescopes to blending hall	34	2	68	136
2.	Conveyor distributors - blending hall	82	2	164	334
3.	Piping - blending hall	22	2	44	90
4.	Seed cotton handling system from blending hall to ginning hall	121	1	121	260
5.	Feed control bin	50	1	50	107
6.	Inclined cleaners	87	1	87	188
7.	Conveyor distributors over gins	383	1	383	830
8.	Feeder units from distributor	494	1	494	1 073
9.	Overflow pen and live overflow system	87	1	87	188
10.	Gins and feeders	11.8	92	1 082	2 341
11.	Seed handling system	100	1	100	216
12.	Lint handling system with condensor	129	1	129	278
13.	Bale press complete	318	1	318	646
14.	Miscellaneous	62	1	62	127
15.	Humidification system	112	1	112	242
16.	Lugatta cleaning plant	77	1	77	157
17.	Scarto recovery and processing plant	67	1	67	137

Note: (1) Excluding civil and building costs.

TABLE 3.24

White Nile - Rabak Ginnery
Costs of Factory Buildings and Civil Works

	Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1.	Civil works for factory modernisation	I	31	100
2.	Press pit	I	13	41
3.	Blending hall buildings (2 Nr)	I	106	270
4.	Lugatta cleaning plant building	I	14	37

mainly to worn bearings or bushes around the centre column, allowing the press to move excessively during tramping and pressing sequences.

(d) The 12 lint cleaners, costing (with their ancillary equipment) in excess of US$ 700 000 have been cannibalised to provide spares for the gin stands and are almost derelict. As mentioned in Section 2.9, additional seed cotton cleaning equipment (yet to be installed) has been purchased under ARP funding for Factories 2, 3 and 4 to enable them to process spindle machine picked cotton. However, as already emphasised, it is essential to use lint cleaners to ensure that the lint produced from machine-picked cotton is equal in cleanliness and value to that produced from hand-picked cotton.

If machine-picked cotton is to be processed, the unit lint cleaners should therefore be completely overhauled. One problem affecting the existing cleaners has been movement of the ginnery floor slabs, and as part of the overhaul it is recommended that new independent concrete block foundations (about 3 m x 2 m) should be provided. Alternatively, consideration could be given to the possibility of replacing the unit lint cleaners with a single battery saw type lint cleaner for each factory. Although air stream lint cleaners would be easier to operate and maintain, they are much less efficient than saw type cleaners, and it is not considered worthwhile to install air stream cleaners in place of the existing lint cleaners.

Proposed improvements are as follows:

(i) Roller conveyors should be provided to assist in feeding bags of seed cotton into the mixing rooms. Present congestion at this point is a potential constraint on production.

(ii) Additional tractors and trailers should be provided for seed cotton transport.

(iii) A lugatta cleaning plant should be added.

(iv) A weighbridge should be installed.

Costs of new equipment, spares and civil and building works are given in Tables 3.25 to 3.27.

3.6.2 Delinting Plant Modifications

Reference has already been made in Section 2.8 to problems at the delinting plant which is designed to be fed mechanically with seed from Factory Nr 1. These problems are as follows :

(i) Downtime at Factory Nr 1 has directly contributed to downtime within the delinting plant, no alternative seed feeding system to the delinting plant being provided. The feeding system has been modified to an unsatisfactory system whereby the fuzzy seed

TABLE 3.25

Rahad Corporation - Fau Ginnery
Costs of New Equipment

	Item	Class[1]	Unit FE cost (US$ '000)	Number required	FE cost (US$ '000)	Total cost[2] (LS '000)
1.	Weighbridge 50 t x 3 m x 18 m	I	35	1	35	71
2.	Heavy duty segments for fan casings - Factories 1, 2, 3 and 4	R	2.2	40	90	182
3.	Lugatta cleaning plant	I	77	1	77	157
4.	Conveyors for bagged seed cotton	I	11	5	56	127
5.	Tractors - seed cotton transport in yard	I	18	5	90	204
6.	Trailers - seed cotton transport in yard	I	13	10	134	303
	Delinting Plant Modifications					
7.	Seed cleaners	R	-	2)		
8.	Piping and collecting cyclones	R	-	2)		
9.	Seed cleaner intake chutes	R	-	2)		
10.	Lint cleaner	R	-	1)	252	513
11.	Linter conveying system	R	-	1)		
12.	Conveying and elevating machinery	R	-	Lot)		

Notes: (1) I - Improved
R - Rehabilitation
(2) Excluding civil and building costs.

TABLE 3.26

Rahad Corporation - Fau Ginnery
Costs of Factory Buildings and Civil Works

	Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1.	Weighbridge civil works and office	I	8	25
2.	Lugatta cleaning plant building	I	14	37
3.	Apron for seed treatment building	R	22	71

TABLE 3.27

Rahad Corporation - Fau Ginnery
Costs of Spares etc.

	Item	FE cost (US$ '000)	Total cost (LS '000)
1.	Murray gin spares	100	193
2.	Datsun fork lift truck spares	1	2
3.	Parkson milling machine - extra machine tools	19	37
4.	Hand tools - workshops	108	208
5.	Centre lathe for bale press rams etc.	32	62
6.	Tractor spares	40	90
7.	Overhaul of Nr 1, 2 and 3 bale presses	168	325
8.	Overhaul of Nr 1, 2, 3 and 4 lint cleaners	67	145
9.	Hand truck components	8	20

is fed by hand from sacks to a bucket elevator within the delinting plant, discharging into the conveyor systems over the saw delinting gins. This involves double handling and extra labour.

(ii) No seed pre-cleaning machinery was provided, although the building was designed with the required space. Damaged seed from the saw gins and blow pipe system is inevitable, as is sand and trash carry-over, and these must contribute to extra wear and tear on the saw delinters.

(iii) No after-cleaning machinery was provided, although the building was designed with the required space. Damaged seed becomes critical at this stage as pure seed for planting must be free from shell coat damage from whatever source.

(iv) At present, linter dust and fly escape into the main delinting hall. The linter collecting cyclones are located upwind of the building, and dust and fly are blown back into the building. The linters conveying and baling system should be located at least in a separate room, and dust extraction systems installed.

(v) The seed chemical dressing plant is poorly maintained, resulting in excessive loss of pesticide powder to the building atmosphere, causing an extreme health hazard.

(vi) There has been considerable movement of floor slabs and machine foundations. A protective apron is required around the building to stop this movement.

It is proposed that the delinting plant should be modified to overcome these problems, and a list of equipment required is given in Table 3.26. However, account should also be taken of the recommendations of the forthcoming FAO report on planting seed before any final investment decision is made.

3.7 New Halfa Ginnery

Built in 1968, the three ginning factories appear to have given satisfactory service. One of the two main problems is static due to lack of humidification. Locally made devices are in use, but the factories would benefit in terms of both production and quality by the use of purpose designed humidification units. The other main problem is shortage and continual interruption of the power supplies. It is recommended that a properly designed power plant be installed (see Chapter 6).

Other recommendations are as follows:

(i) The existing mixing rooms are too small, causing a constraint on the supply of seed cotton. The mixing rooms at each factory should be extended and a second suction telescope provided.

(ii) The factories should be widened by construction of a lean-to extension over a length of about 15 m behind the gin stands, to provide more working space for maintenance.

(iii) The hydraulic feed control systems on the gin stands should be reinstated.

(iv) The press pumps should be replaced as the existing ones are obsolete and spares are almost impossible to obtain.

(v) Additional equipment should be provided for the lugatta cleaning plant, and a building provided.

The proposed new equipment and spares requirements are listed in Tables 3.28 and 3.29, and the costs of building works are given in Table 3.30.

In view of the increasing age of these factories, it would be beneficial to install a fourth factory on the site to take the pressure off the existing plants and allow more time for maintenance. However, as described in Chapter 4, it is felt that the production projections are not certain enough to recommend such an investment at the present time.

3.8 Zeidab Ginnery

Although most of the equipment at this ginnery is very old, it is in fair condition, and is generally adequate to handle the relatively small volume of seed cotton requiring to be processed. However, it is recommended that the existing press, dating from 1926, should be replaced by a more recent manual press taken from one of the SGB factories to be modernised.

The only new equipment proposed is replacement of the scarto gin stands. The costs of this and spares requirements are shown in Tables 3.31 and 3.32.

3.9 Port Sudan Ginnery

The equipment at this ginnery is also old, but as at Zeidab, it is expected to be able to continue to handle the small projected production, particularly in view of the long available ginning season. However, replacement of the scarto gin stands is proposed. Additional equipment for seed cotton transport is also required. The costs of new equipment and spares requirements are shown in Tables 3.33 and 3.34.

The factory building itself is in poor condition and considerable remedial works are required as indicated in Table 3.35.

3.10 Nuba Mountains Ginneries

It is difficult to justify major expenditure at the Nuba Mountains ginneries as the existing capacity exceeds the crop. However, some investment is necessary if only to avoid any possible reversal of the situation due to machinery failure caused by lack of spares and to replace obsolete plant. Lack of good roads, a relatively short ginning season, and the need to evacuate bales and seed before the rains set in are further reasons for at least maintaining the ginneries in good order.

The recommendations for improvements and rehabilitation are as follows:

(i) Humidification systems should be installed at all ginneries.

TABLE 3.28

New Halfa Ginnery
Costs of New Equipment

	Item	Class[1]	Unit FE unit (US$ '000)	Number required	FE cost (US$ '000)	Total cost[2] (LS '000)
1.	Humidification systems - Factories 1, 2 and 3	I	55	3	165	336
2.	Seed cotton suction telescope and piping - Factories 1, 2 and 3	R	8	3	24	48
3.	Press pumps	R	56	3	168	342
4.	Extra lugatta cleaning equipment	R	40	1	40	81

Notes: (1) I - Improvement
R - Rehabilitation
(2) Excluding civil and building costs.

TABLE 3.29

New Halfa Ginnery
Costs of Factory Buildings and Civil Works

	Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1.	Widen factories (3 Nr)	I	19	48
2.	Extend mixing rooms (3 Nr)	I	28	72
3.	Lugatta cleaning plant building	R	14	37

TABLE 3.30

New Halfa Ginnery
Costs of Spares

	Item	FE cost (US$ '000)	Total cost (LS '000)
1.	Gin and press spares	101	205
2.	Workshop tools and equipment	56	114

TABLE 3.31

Northern Corporation - Zeidab Ginnery
Costs of New Equipment

Item	Class(1)	Unit FE cost (US$'000)	Number required	FE cost (US$ '000)	Total cost (LS '000)
1. Scarto gin stand	R	18	1	18	37
2. Installation of secondhand bale press	R	5	1	5	15

Note : (1) R - Rehabilitation

TABLE 3.32

Northern Corporation - Zeidab Ginnery
Costs of Spares

Item	FE cost (US$ '000)	Total cost (LS '000)
1. Gin and press spares	17	34
2. Workshop tools and equipment	8	16

TABLE 3.33

Tokar Corporation - Port Sudan Ginnery
Costs of New Equipment

Item	Class(1)	Unit FE cost (US$ '000)	Number required	FE cost (US$ '000)	Total cost (LS '000)
1. Scarto gin stands	R	18	2	36	74
2. Tractors - seed cotton transport in yard	I	18	1	18	41
3. Trailers - seed cotton transport in yard	I	13	2	27	61

Notes : (1) R - Rehabilitation
I - Improvement

TABLE 3.34

Tokar Corporation - Port Sudan Ginnery
Costs of Factory Buildings and Civil Works

Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1. Replace roof members	R	39	93
2. Replace roof and wall cladding	R	21	68

TABLE 3.35

Tokar Corporation - Port Sudan Ginnery
Cost of Spares

Item	FE cost (US$ '000)	Total cost (LS '000)
1. Workshop tools and equipment	17	34
2. Gin and press spares	22	43

(ii) The cotton seed bagging arrangements at all ginneries should be improved by the addition of seed cyclones. Seed blowers and piping should also be provided at Umm Berembeita and Dilling.

(iii) The flat belt drives at Kadugli, Talodi and Kalogi should be modified to vee belt drives.

(iv) The saw gin stands at Umm Berembeita, Semeih and Dilling (which are more than 50 years old) are obsolete and should be replaced. It is proposed that two new 90-saw gin stands should be provided at each ginnery, similar to those at the other ginneries.

This would allow two of the four existing gins at each ginnery to be retained, with spares provided from those removed, but it is expected that in practice the new gins would be able to handle the whole production.

(v) Umm Berembeita ginnery presents a particular problem. In addition to the obsolete gin stands, it has an obsolete John Shaw press and is powered by an obsolete gas producing plant, using cotton seed as fuel. The ginnery should perhaps be closed down as the size of the local cotton crop hardly justifies its existence. It was in fact shut down for several years, and the seed cotton transported to Semeih or Abu Gebeiha, but the corporation maintains that this was too expensive, and has reopened the plant. Assuming that the ginnery is to be kept in operation, it is proposed that the existing press should be replaced with one of the later models to be removed from an SGB factory. Eventually, the gas engine would also have to be replaced, as it would be impossible to obtain spares should a major part fail. However, the cost of a new diesel installation similar to that at Dilling (about US $ 200 000) might be difficult to justify. A possible cheaper solution would be to provide a fast-moving diesel generator coupled to a single motor driving the lineshaft.

(vi) A small workshop (10 m x 4 m) should be provided at each ginnery.

(vii) Some of the cladding at Abu Gebeiha and the roof cladding and part of the wall cladding at Semeih require to be replaced. At Lagowa a complete new roof structure is required for the mixing room, although only about half the area of the present building needs to be covered.

Having regard to potential production, it is suggested that priority should be given to investments in the ginneries at Kadugli, Kologi, Talodi and Semeih. Kadugli in particular is likely to have the highest production, and the local cotton crop may exceed the capacity of the ginnery. An alternative to providing new gin stands for Umm Berembeita and Dilling would be to install new plant of higher capacity at Kadugli and to transfer the existing plant to Umm Berembeita and/or Dilling. This option should be renewed in the light of future production trends.

Details of costs of rehabilitation and improvements are given in Tables 3.36 to 3.38.

TABLE 3.36

Nuba Mountains - All Ginneries
Costs of New Equipment

Item	Class(1)	Unit FE cost (US$'000)	Number required	FE cost (US$'000)	Total cost(2) (LS'000)
1. Seed cyclones - all ginneries	I	68	8	54	110
2. Seed blowers with associated piping - Umm Berembeita and Dilling	I	22	2	45	92
3. Modify drives from flat belt to vee belt - Kadugli, Talodi, Kologi	R	6	3	17	34
4. Saw gin stands - Umm Berembeita, Semeih and Dilling (2 per ginnery)	R	28	6	168	342
5. Installation of secondhand press - Umm Berembeita	R	5	1	5	15
6. Humidification systems - all ginneries	I	55	8	439	893

Notes : (1) I - Improvement
R - Rehabilitation

(2) Excluding civil and building costs.

TABLE 3.37

Nuba Mountains - All Ginneries
Costs of Factory Buildings and Civil Works

Item	Class	FE cost (US$ '000)	Total cost (LS '000)
1. Workshop buildings (8 Nr)	I	28	100
2. Replace part of roof cladding - Abu Gebeiha and Semeih	R	5	16
3. New roof for mixing room - Lagowa	R	13	31

TABLE 3.38

Nuba Mountains - All Ginneries
Costs of Spares

	Item	FE cost (US$ '000)	Total cost (LS '000)
1.	Ruston main engine - Abu Gebeiha	45	87
2.	Ruston main engine - Semeih	45	87
3.	Ruston main engine - Lagowa	45	87
4.	Ruston main engine - Dilling	53	102
5.	Caterpillar main engines (3 Nr)	112	218
6.	Gins and presses - Murray	112	218
7.	Workshop tools and equipment	56	108

TABLE 3.39

Farmers Marketing Corporation - Damazin Ginnery
Costs of Spares

	Item	FE cost (US$ '000)	Total cost (LS '000)
1.	Gins and bale press - Murray	84	163
2.	Workshop tools and equipment	56	109

TABLE 3.40

Costs of Electrical Installations for Factory Modernisation

	Item	FE cost (US$ '000)	Total cost (LS '000)
1.	Marangan - Factories 1, 2, 3	101	225
2.	Hasaheisa - Factories 7, 8, 13	84	188
3.	Kassab Factory Nr 1		
	- LV switchboard	30	67
	- distribution system	40	89
4.	Rabak		
	- LV switchboard	42	102
	- distribution system	60	134

3.11 Damazin Ginnery

No new equipment is proposed for this ginnery. It is recommended that the trash cyclones should be relocated downwind of the ginnery building. Spares requirements are shown in Table 3.39.

As mentioned in Section 2.9, it is understood that machine-harvested seed cotton pre-cleaning equipment is to be installed under ARP funding. However, it is in this area that stripper harvesters have recently been introduced, and it is considered that the new cleaning equipment is suitable only for spindle machine picked seed cotton. This matter requires further clarification. The lint cleaners are in reasonably good condition and could be made operational with the minimum of attention.

3.12 Electrical Distribution at Ginneries

3.12.1 Existing Installations

A detailed description of HV and LV switchgear and distribution transformers at each ginnery together with single line electrical diagrams is given in Annex 1 - Inventory.

Most ginneries with an NEC supply take power at 415 volts from the LV terminals of an NEC owned 11 000/433 volt distribution transformer. However, the larger sites such as Marangan and Hasaheisa take power at 11 kV, and have a consumer owned 11 kV ring main system, comprising 11 kV oil immersed switchgear and 11 000/433 volt distribution transformers at each factory, interconnected by 11 kV PILC/SWA cable between factories.

At a number of ginneries the electrical switchgear is of the order of 20 years old with equipment manufactured by such firms as British Thompson Houston, AEI Co. and Crompton Parkinson, but still proving safe, reliable and in good order although spare parts are now difficult if not impossible to obtain. Automatic power factor correction is installed at most ginneries to ensure a minimum of 0.85 lag but at some of the older sites the relays for automatic control are in disrepair and are now obsolete.

At the older ginneries motor control is by local individual motor starters either direct on line, oil immersed star delta or oil immersed resistance start as appropriate. Spare parts for these appear to be generally difficult to obtain and the starters can probably be considered obsolete.

Cabling within factories is generally MICC (imperial sizes) and difficulty is now being encountered by maintenance staff in obtaining imperial glands, seals, etc. as old stocks of spare parts diminish.

The modern saw ginneries such as Fau and Damazin have motor control centres for central switching and control of motors. A typical manufacturer is Klockner Moeller and spare parts can be obtained provided accurate manufacturer's descriptions, part numbers, etc. are given.

3.12.2 Improvements and Rehabilitation

Improvement of electrical installations would mainly concern those ginning factories where major modernisation is proposed. At SGB Factories 1, 2, 3, 7, 8 and 13, extensions to the LV switchboards would be required, together with

additional cabling. At Rabak, a new LV switchboard/control panel is required to replace the existing switchboard (which is obsolete and in a dangerous condition), and general rewiring would also be carried out. It is similarly proposed that a new LV switchboard and distribution system should be provided at Kassab Nr 1. The estimated costs for these factories are given in Table 3.40. At other factories, proposed improvements would involve only minor electrical works, and separate cost estimates have not been made.

Rehabilitation of existing electrical installations at ginning factories would involve the supply of spare parts and the replacement of some items. Detailed costs have been estimated as given in Table 3.41. Those costs for factories at Marangan, Hasaheisa, Bageir and Fau are based on information obtained during site visits but for the other ginnery locations, cost estimates have been made on a pro rata basis because of the difficulty in obtaining detailed spare parts and replacement requirements within the time scale of the site visits. The cost estimates allow for some replacement of old and obsolete equipment where it is anticipated that spare parts will not be easily obtained. It is assumed that installation would, in all cases, be carried out by ginnery staff.

In addition allowance has been made for the supply of tools for electrical maintenance.

TABLE 3.41

Costs of Spares for Factory Electrical Installations (US$)

	GINNERY					
	Marangan Hasaheisa Bageir	Sennar	Hamadnallah	Kassab	Dueim	Kosti
MICC cabling	181 750	14 000	14 000	14 000	14 000	14 000
PVC/SWA/PVC cabling	170 250	13 100	13 100	13 100	13 100	13 100
Lamps	55 800	4 300	4 300	8 600	4 300	4 300
Earthing	3 250	250	250	500	250	250
Fuse switches, distribution boards, socket outlets, etc.	65 150	5 000	5 000	7 500	5 000	5 000
11 kV cabling accessories	70 750	-	-	-	-	-
Motor rewind materials/ replacement motors	93 500	7 200	7 200	14 400	7 200	7 200
Motor bearings	66 500	5 100	5 100	10 200	5 100	5 100
Motor starters	107 600	8 300	8 300	16 600	8 300	8 300
11 kV switchgear	52 100	-	-	-	-	-
415 V switchgear	13 100	-	-	-	-	-
Tools	34 050	2 600	2 600	2 600	2 600	2 600
TOTAL FE COST (US $)	913 800	59 850	59 850	87 500	59 850	59 850
TOTAL COST (LS)	1 948 200	127 600	127 600	186 550	127 600	127 600

TABLE 3.41 (cont.)

	GINNERY				
	Fau	New Halfa	Zeidab	Port Sudan	Damazin
MICC cabling	-	14 000	14 000	14 000	14 000
PVC/SWA/PVC cabling	-	13 100	13 100	13 100	13 100
Lamps	9 000	4 300	4 300	4 300	4 300
Earthing	-	250	250	250	250
Fuse switches, distribution boards, socket outlets, etc.	-	5 000	5 000	5 000	5 000
11 kV cabling accessories	-	-	-	-	-
Motor rewind materials/ replacement motors	-	7 200	7 200	7 200	7 200
Motor bearings	)	5 100	5 100	5 100	5 100
Motor starters	) 100 000)	8 300	8 300	8 300	8 300
11 kV switchgear	-	-	-	-	-
415 V switchgear	18 000	39 300	-	-	-
Tools	-	2 600	2 600	2 600	2 600
TOTAL FE COST (US $)	127 000	99 150	59 850	59 850	59 850
TOTAL COST (LS)	246 000	211 400	127 600	127 600	127 600

CHAPTER 4

GINNING CAPACITY

4.1 Factors to be Considered

In planning the future capacity of ginning facilities in Sudan it is necessary to consider the following factors :

(a) Future seed cotton production: the projections of future production must take account of areas planted, yields, market constraints and the balance between long and medium staple varieties, as well as particular characteristics of each production scheme.

(b) Current plans for new ginning capacity: these affect the Gezira where modernisation of some existing factories and the addition of two new saw gin factories are proposed under the Gezira Rehabilitation Project.

(c) The effects of proposed improvements on the capacities of existing factories, taking account of the proposed introduction of a standard 6-day week.

4.2 Seed Cotton Production Projections

4.2.1 General

The decline in production in the 1970s on the one hand, and on the other hand the investment programmes now being implemented to rehabilitate several of the major irrigation schemes, mean that past production records (see Tables 4.1 and 4.2) are of limited value as a basis for forecasting future seed cotton production and long term projections are subject to considerable uncertainty.

Apart from the general uncertainty about future yields (Section 4.2.3), the main uncertainties are the limit composed on total long staple production by market constraints (Section 4.2.2) and the location of the areas allocated to grow long staple. The schemes where long staple has been grown in the past are :

Gezira

Blue Nile pump schemes

White Nile pump schemes

Tokar

The production of Tokar is small and it is assumed that this scheme will continue to produce long staple cotton. In order to examine the range of options for allocation of long staple and medium staple production between Gezira and the pump schemes three cases have been formulated as follows:

Case A : Base case

	Area planted, 1990/91 (feddans)	
	Long staple	Medium staple
Gezira	350 000	150 000
Blue Nile	-	100 000
White Nile	39 000	88 000

Total long staple production (1990/91): 281 000 tonnes seed cotton (500 000 bales lint)

Case B : Blue and White Nile pump schemes growing long staple only

	Area planted, 1990/91 (feddans)	
	Long staple	Medium staple
Gezira	190 000	310 000
Blue Nile	100 000	-
White Nile	127 000	-

Total long staple production (1990/91): 281 000 tonnes seed cotton (500 000 bales lint)

Case C : Blue and White Nile pump schemes growing medium staple only

	Area planted, 1990/91 (feddans)	
	Long staple	Medium staple
Gezira	480 000	20 000
Blue Nile	-	100 000
White Nile	-	127 000

Total long staple production (1990/91): 350 000 tonnes seed cotton (625 000 bales lint)

Projections for all three cases have been formulated taking account of:

- projections prepared by the Ministry of Finance and Economic Planning and published by the Consultants in the Inception Report, April 1983 (see Table 4.3);
- consideration of past performance;
- consideration of long staple market constraints;
- comments of the study working party on the projection given in the Inception Report and Interim Progress Report.

TABLE 4.1

Area Under Cotton 1973/74 to 1982/83
('000 feddans)

	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83*
Long staple										
Gezira	589	588	381	476	473	409	446	417	380	374
Blue Nile)	235	250	216	64	67	67	156	(61	51	18
White Nile)								(61	63	54
Tokar	-	-	-	-	-	22	13	14	20	14
Sub total	824	838	597	540	540	498	615	553	514	460
Medium staple										
Gezira	15	15	22	22	45	89	94	74	55	109
New Halfa	110	108	81	109	89	86	62	55	58	80
Rahad	-	-	-	-	50	80	88	88	125	116
Blue Nile)	-	-	-)	101	109	89	7	(-	-	31
White Nile)	-	-	-)					(-	-	26
Suki	34	37	37	38	32	31	31	28	26	26
Zeidab	5	7	7	7	6	5	6	6	6	6
Other	33	57	60	10	66	-	-	-	-	-
Sub total	197	224	207	287	397	380	288	251	270	394
Short staple										
Nuba	124	104	118	119	105	87	38	54	43	73
Acrain	-	18	18	27	31	32	38	66	35	17
Other	33	-	-	-	-	-	-	-	-	-
Sub total	157	122	136	146	136	119	76	120	78	90
Total All Cotton	1 178	1 184	940	986	1 073	997	979	924	862	944

Note : * Estimated as at 14th March, 1983

Source: Cotton Public Corporation

TABLE 4.2

Production of Cotton Lint 1973/74 to 1982/83
('000 bales*)

	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83+
Long staple										
Gezira	741	669	260	438	496	301	274	218	370	373
Blue Nile)	268	255	155	64	52	32	59	(25	23	10
White Nile)								(40	43	41
Tokar	-	-	-	-	-	7	1	4	8	4
Sub total	1 009	924	415	502	548	340	334	287	444	428
Medium staple										
Gezira	27	25	15	26	98	133	97	68	71	187
New Halfa	119	121	41	106	107	46	17	30	63	91
Rahad	-	-	-	-	83	78	103	67	183	208
Blue Nile)	-	-	-)	84	98	72	3	(-	-	20
White Nile)	-	-	-)					(-	-	22
Suki	38	39	39	68	51	33	23	17	30	29
Zeidab	6	7	8	8	5	5	4	5	4	5
Other	15	16	22	6	4	-	-	-	-	-
Sub total	205	208	125	298	446	367	247	187	350	562
Short staple										
Nuba	17	20	25	24	19	18	4	10	8	16
Acrain	-	6	7	10	7	7	13	22	11	10
Other	7	-	-	-	-	-	-	-	-	-
Sub total	24	26	32	34	26	25	17	32	19	26
Total All Cotton	1 238	1 158	572	834	1 020	732	598	506	813	1 016

Notes : * Based on average bale weight of 420 lb
\+ Estimated as at 14th March, 1983
Source: Cotton Public Corporation

TABLE 4.3

First Estimate of Future Seed Cotton Production as Presented in Inception Report (April 1983)

	1982/83(2)			1984/85			1990/91		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
Long staple									
Gezira	375	4.3	1 613 (230)	340	4.5	1 530 (218)	320	5.5	1 760 (251)
Blue Nile	18	2.3	41 (6)	40	3.5	140 (20)	61	4.0	244 (35)
White Nile	54	3.3	178 (25)	100	3.5	350 (50)	111	4.25	472 (67)
Tokar	15	1.2	18 (3)	20	1.5	30 (4)	25	2.0	50 (7)
Sub total	462		1 850 (264)	500		2 050 (292)	517		2 526 (360)
Medium staple									
Gezira	109	5.9	643 (92)	160	5.8	928 (131)	180	6.5	1 170 (167)
Blue Nile	31	2.3	71 (10)	40	3.5	140 (20)	39	4.8	187 (27)
Suki	26	5.0	130 (18)	35	4.4	154 (22)	40	5.9	236 (34)
White Nile	26	2.7	70 (10)	-	-	- -	-	-	- -
Rahad	116	7.4	858 (122)	130	5.8	754 (108)	130	6.5	845 (121)
New Halfa	80	4.8	384 (55)	90	4.5	405 (58)	100	6.5	650 (93)
Zeidab	6	3.4	20 (3)	6	4.0	24 (3)	6	4.25	26 (4)
Sub total	394		2 176 (310)	461		2 405 (342)	495		3 114 (446)
Short staple									
Nuba Mountains	73	0.8	58 (8)	120	1.1	132 (19)	220	1.4	308 (43)
MFC and other	17	0.9	15 (2)	65	1.8	117 (17)	105	2.0	210 (30)
Sub total	90		73 (10)	185		249 (36)	225		518 (73)
Total	946		4 099 (584)	1 146		4 704 (670)	1 237		6 158 (879)

Notes : (1) Units :
Area - tjpisamd feddans
Yield - kantars/feddan
Production - thousand kantars (thousand tonnes in brackets)
(2) Figures for 1982/83 are actual

Source : Ministry of Finance and Economic Planning, Abdul Sattar

The detailed projections for each case are given in Tables 4.4 to 4.6 and are discussed in Sections 4.2.4 to 4.2.6. The basic assumptions underlying all the projections are:

(i) Rehabilitation projects will be implemented for Gezira, Blue Nile pump schemes, White Nile pump schemes and New Halfa.

(ii) An investment programme for rainfed cotton will be implemented.

(iii) A rehabilitation project for Suki will be forthcoming, increasing cultivation to 90 000 feddans.

(iv) The present seed cotton pricing policy will continue to be effective giving a stable price with a slight upward trend to give confidence to groups.

(v) The supply of agricultural inputs will be maintained.

Any estimates of production beyond 1990 must be very tentative. It is suggested, however, that a 0.5 kantars/feddan yield improvement above 1990/91 yields for both long and medium staple may be achieved by 1995.

4.2.2 Limit on Long Staple Production

The first projections put forward in the Inception Report assumed long staple production of 640 000 bales (360 000 tonnes seed cotton) in 1990/91. However, further studies of the market constraints on long staple production (Annex 7 Section 1.3.2) indicate that market prospects will limit long staple production to 500 000 bales (281 000 tonnes of seed cotton). The projections for Cases A and B are based on this limit. Case C has long staple production in 1990/91 of 625 000 bales (350 000 tonnes of seed cotton). This is a consequence of limiting the area of medium staple in the Gezira to 20 000 feddans, but it is useful in showing the effect of increased long staple production on required ginning capacity.

4.2.3 Yields

Seed cotton yields for 1973/74 to 1982/83 for the various producing areas are given in Table 4.7. Although yields have shown large variations over the past ten years they provide some basis for reviewing the estimates of future yields. Taking account of the historic yields and other factors the yields put forward as a basis for the first estimates of future production were amended as follows:

(i) Gezira

Long staple yield taken as 5 kantars/feddan in 1990/91 rather than 5.5. This is based on part performance and is the estimate given in the Gezira Rehabilitation Project Report (Euroconsult 1982).

Medium staple yield taken as 6.0 kantars/feddan in 1984/85 rather than 5.8, based on past performance.

TABLE 4.4

Estimated Future Seed Cotton Production
Case A - Base Case

	1982/83(2)			1984/85			1990/91		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
Long staple									
Gezira	375	4.3	1 613 (230)	350	4.5	1 575 (225)	350	5.0	1 750 (250)
Blue Nile	18	2.3	41 (6)	4	3.5	14 (2)	-	-	- -
White Nile	54	3.3	178 (25)	100	3.5	350 (50)	39	4.25	166 (24)
Tokar	15	1.2	18 (3)	20	1.5	30 (4)	25	2.0	50 (7)
Sub total	462		1 850 (264)	474		1 969 (281)	414		1 966 (281)
Medium staple									
Gezira	109	5.9	643 (92)	150	6.0	900 (129)	150	6.5	975 (139)
Blue Nile	31	2.3	71 (10)	76	3.5	266 (38)	100	5.0	500 (72)
Suki	26	5.0	130 (18)	35	5.0	165 (25)	40	6.0	240 (34)
White Nile	26	2.7	70 (10)	-	-	- -	88	4.5	396 (57)
Rahad	116	7.4	858 (122)	135	7.0	945 (135)	140	7.5	1 050 (150)
New Halfa	80	4.8	384 (55)	90	5.0	450 (64)	100	6.0	600 (86)
Zeidab	6	3.4	20 (3)	6	4.0	24 (3)	6	4.25	26 (4)
Sub total	394		2 176 (310)	492		2 750 (394)	624		3 787 (542)
Short staple									
Nuba Mountains	73	0.8	58 (8)	120	1.1	132 (19)	220	1.3	286 (41)
MFC and other	17	0.9	15 (2)	65	1.8	117 (17)	105	2.0	210 (30)
Sub total	90		73 (10)	185		249 (36)	325		496 (71)
Total	946		4 099 (584)	1 151		4 968 (711)	1 363		6 249 (894)

Notes : (1) Units :
Area - thousand feddans
Yield - kantars/feddan
Production - thousand kantars (thousand tonnes in brackets)
(2) Figures for 1982/83 are actual

TABLE 4.5

Estimated Future Seed Cotton Production
Case B - Blue and White Nile Pump Schemes, Long Staple Only

	1982/83(2)			1984/85			1990/91		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
Long staple									
Gezira	375	4.3	1 613 (230)	290	4.5	1 305 (187)	190	5.0	950 (136)
Blue Nile	18	2.3	41 (6)	80	3.5	280 (40)	100	4.25	425 (61)
White Nile	54	3.3	178 (25)	100	3.5	350 (50)	127	4.25	540 (77)
Tokar	15	1.2	18 (3)	20	1.5	30 (4)	25	2.0	50 (7)
Sub total	462		1 850 (264)	490		1 965 (281)	442		1 965 (281)
Medium staple									
Gezira	109	5.9	643 (92)	210	6.0	1 260 (180)	310	6.5	2 015 (288)
Blue Nile	31	2.3	71 (10)	-	-	- -	-	-	- -
Suki	26	5.0	130 (18)	35	5.0	165 (25)	40	6.0	240 (34)
White Nile	26	2.7	70 (10)	-	-	- -	-	-	- -
Rahad	116	7.4	858 (122)	135	7.0	945 (135)	140	7.5	1 050 (150)
New Halfa	80	4.8	384 (55)	90	5.0	450 (64)	100	6.0	600 (86)
Zeidab	6	3.4	20 (3)	6	4.0	24 (3)	6	4.25	26 (4)
Sub total	394		2 176 (310)	476		2 844 (407)	596		3 931 (562)
Short staple									
Nuba Mountains	73	0.8	58 (8)	120	1.1	132 (19)	220	1.3	286 (41)
MFC and other	17	0.9	15 (2)	65	1.8	117 (17)	105	2.0	210 (30)
Sub total	90		73 (10)	185		249 (36)	325		496 (71)
Total	946		4 099 (584)	1 151		5 058 (724)	1 363		6 392 (914)

Notes : (1) Units :
- Area - thousand feddans
- Yield - kantars/feddan
- Production - thousand kantars (thousand tonnes in brackets)

(2) Figures for 1982/83 are actual

TABLE 4.6

Estimated Future Seed Cotton Production
Case C - Blue and White Nile Pump Schemes, Medium Staple Only

	1982/83(2)			1984/85			1990/91		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
Long staple									
Gezira	375	4.3	1 613 (230)	430	4.5	1 935 (277)	480	5.0	2 400 (343)
Blue Nile	18	2.3	41 (6)	-	-	- -	-	-	- -
White Nile	54	3.3	178 (25)	-	-	- -	-	-	- -
Tokar	15	1.2	18 (3)	20	1.5	30 (4)	25	2.0	50 (7)
Sub total	462		1 850 (264)	450		1 965 (281)	505		2 450 (350)
Medium staple									
Gezira	109	5.9	643 (92)	70	6.0	420 (60)	20	6.5	130 (19)
Blue Nile	31	2.3	71 (10)	80	3.5	280 (40)	100	5.0	500 (72)
Suki	26	5.0	130 (18)	35	5.0	165 (25)	40	6.0	240 (34)
White Nile	26	2.7	70 (10)	100	3.5	350 (50)	127	4.5	572 (82)
Rahad	116	7.4	858 (122)	135	7.0	945 (135)	140	7.5	1 050 (150)
New Halfa	80	4.8	384 (55)	90	5.0	450 (64)	100	6.0	600 (86)
Zeidab	6	3.4	20 (3)	6	4.0	24 (3)	6	4.25	26 (4)
Sub total	394		2 176 (310)	516		2 634 (377)	533		3 118 (447)
Short staple									
Nuba Mountains	73	0.8	58 (8)	120	1.1	132 (19)	220	1.3	286 (41)
MFC and other	17	0.9	15 (2)	65	1.8	117 (17)	105	2.0	210 (30)
Sub total	90		73 (10)	185		249 (36)	225		496 (71)
Total	946		4 099 (584)	1 151		4 848 (694)	1 263		6 064 (868)

Notes : (1) Units :
Area - thousand feddans
Yield - kantars/feddan
Production - thousand kantars (thousand tonnes in brackets)
(2) Figures for 1982/83 are actual

TABLE 4.7

Average Seed Cotton Yields 1973/74 to 1982/83
(kantars/feddan)

	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83
Long staple (Barakat)										
Gezira	5.02	4.60	2.81	4.00	4.06	2.85	2.44	2.11	3.92	4.31
Blue Nile)	4.10	3.71	2.97	3.50	2.99	1.95	1.90	(1.78	1.85	2.25
White Nile)								(2.56	2.54	3.25
Tokar	-	-	-	-	-	0.96	0.30	1.21	1.49	1.20
Medium staple										
Gezira	-	-	-	-	7.48	5.10	4.28	3.49	5.08	5.91
Blue Nile)	-	-	-	3.29	3.06	-	-	-	-	2.45
White Nile)										
Suki	4.17	3.80	4.15	6.65	6.15	4.10	2.63	2.16	4.02	4.95
Rahad	-	-	-	-	6.14	3.70	4.45	2.87	6.06	7.37
New Halfa	3.87	4.00	1.78	3.69	4.11	2.01	0.91	2.00	3.78	4.82
Zeidab	4.20	3.30	4.71	4.71	2.50	3.20	3.20	3.12	2.44	3.40
Short staple										
Nuba Mountains	0.60	0.85	0.86	0.86	0.91	0.90	0.52	0.76	1.11	0.76
MFC and others	-	1.40	1.45	1.40	0.80	0.80	1.26	1.62	1.25	0.87

(ii) Blue Nile

Long staple yield taken as 4.25 kantars/feddan in 1990/91 rather than 4.0. The World Bank Appraisal Report for the Rehabilitation Project gives a yield of 4.8 kantars/feddan. This is considered to be high taking account of past performance. Medium staple yield for 1990/91 was increased from 4.8 to 5.0 kantars/feddan on the basis of past performance at Suki.

(iii) White Nile

Medium staple yield of 4.5 kantars/feddan in 1990/91. This relatively low yield was adopted because of the long time scale required for the overall rehabilitation of the whole of the White Nile schemes and taking account of the late planting restriction imposed by the White Nile water level regime and pumping station constraints.

(iv) Suki

Projected yields for Suki were increased to 5.0 and 6.0 kantars/feddan in 1984/85 and 1990/91 respectively based on a consideration of past performance.

(v) Rahad

Projected yields for Rahad were increased to 7.0 and 7.5 kantars/feddan for 1984/85 and 1990/91 respectively. This is based on a consideration of past performance, in particular the average yield achieved in 1982/83 of 7.4 kantars/feddan.

(vi) New Halfa

Projected yield for New Halfa was increased from 4.5 to 5.0 kantars/feddan in 1984/85. This is based on the fact that a yield of 4.8 kantars/feddan was achieved in 1982/83. It is considered however that a yield of 6.5 kantars/feddan in 1990/91 is over optimistic taking into account the consistently relatively low yields in past years and it was therefore reduced to 6.0.

In addition to the amendments to yield projections, the total cotton area for the White Nile was increased from 110 000 feddans to 127 000 feddans in 1990. This accords with the area given in the World Bank Appraisal Report. The area for Rahad was increased to 135 000 feddans in 1984/85 and 140 000 feddans in 1990/91 based on the scheme management's plans.

The projections given in Table 4.7 are estimated average production and in practice yields will fluctuate from year to year. Tables 4.8 and Figure 4.1 show the annual variation of yields in the Gezira for the last 20 years and illustrate the variations to be expected. A preliminary frequency analysis of the variation indicates that one year in five a peak yield of about 0.5 kantars/feddan above the average yield can be expected and one year in ten a peak of about 0.8 kantars/feddan above the average will occur.

TABLE 4.8

Annual Variation of Long Staple (Barakat) Yields in Gezira for Last 20 Years

Year	Yield (kantars/feddan)	Five year moving average yield (kantars/feddan)	Deviation from 5 year moving average (kantars/feddan)	Ranking of deviation
1963/64	2.29	4.14	- 1.85	18
1964/65	3.55	3.63	- 0.08	11
1965/66	3.67	3.55	+ 0.12	7
1966/67	4.06	4.13	- 0.07	10
1967/68	4.18	4.43	- 0.25	13
1968/69	5.21	4.78	+ 0.43	5
1969/70	5.04	4.96	+ 0.08	8
1970/71	5.41	4.94	+ 0.47	4
1971/72	4.98	4.91	+ 0.08	9
1972/73	4.06	4.81	- 0.75	15
1973/74	5.02	4.29	+ 0.73	2
1974/75	4.60	4.10	+ 0.50	3
1975/76	2.81	4.10	- 1.29	17
1976/77	4.00	3.66	+ 0.34	6
1977/78	4.06	3.23	+ 0.83	1
1978/79	2.85	3.09	- 0.24	12
1979/80	2.44	3.08	- 0.64	14
1980/81	2.11	3.12	- 1.01	16
1981/82	3.92	-		
1982/83	4.31	-		
Mean	3.93			

4.2.4 Case A - Base Case

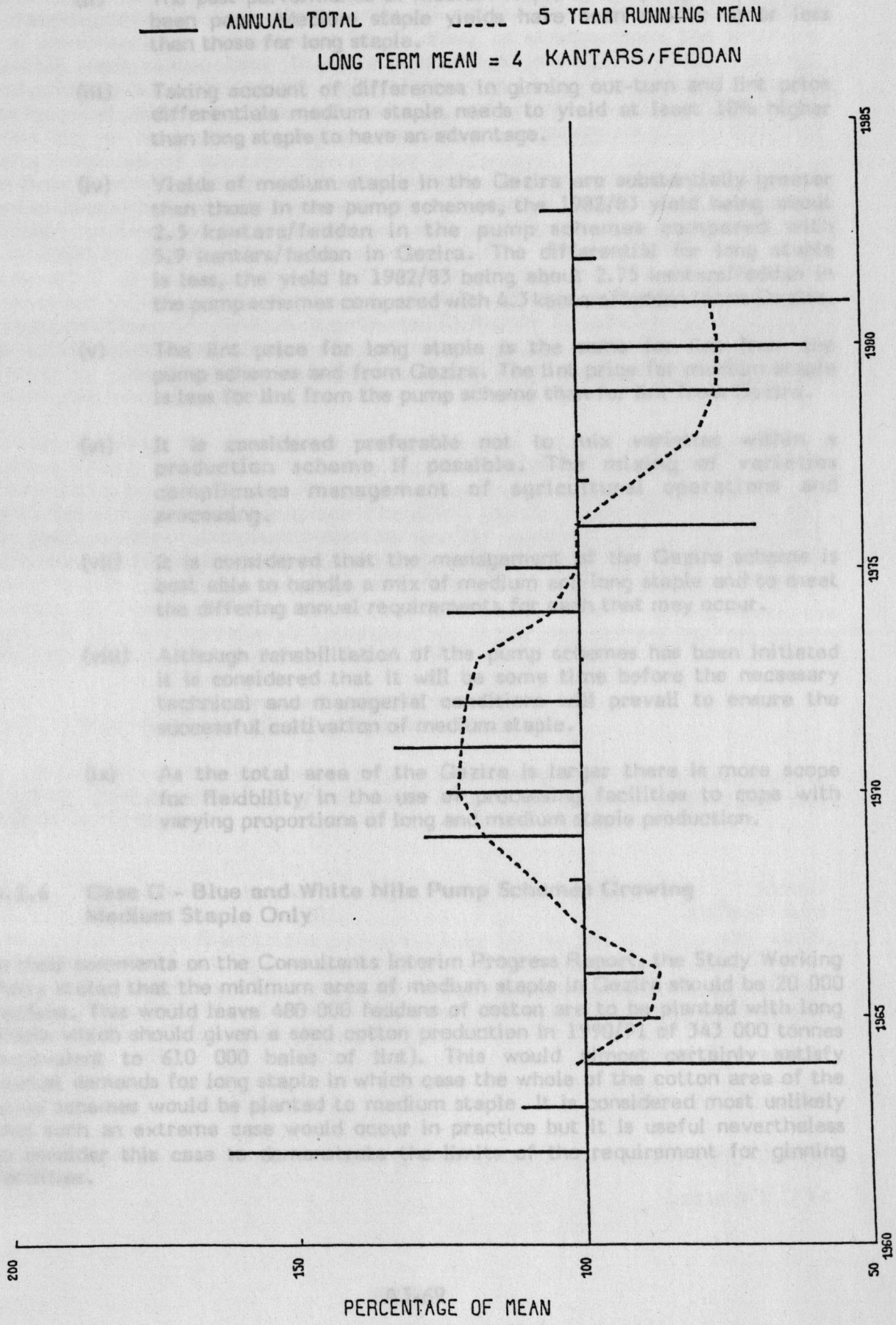
This case (Table 4.4) is based on the assumption that medium staple production in Gezira is limited to an area of 150 000 feddans (in accordance with the instructions of the Study Working Party). In this case the balance (350 000 feddans) of the Gezira cotton area would be allocated to long staple with an estimated 1990/91 production of 250 000 tonnes of seed cotton. Due to the overall constraint on long staple production most of the Blue and White Nile areas would have to grow medium staple. On the basis of past performance White Nile and Blue Nile yields for long staple are similar but it is expected that due to irrigation constraints the medium staple yields would be lower in White Nile than Blue Nile. In these circumstances it is better to grow the balance of the long staple production in the White Nile area rather than in the Blue Nile area. Therefore both long and medium staple could be grown in the White Nile area but only medium staple in the Blue Nile area.

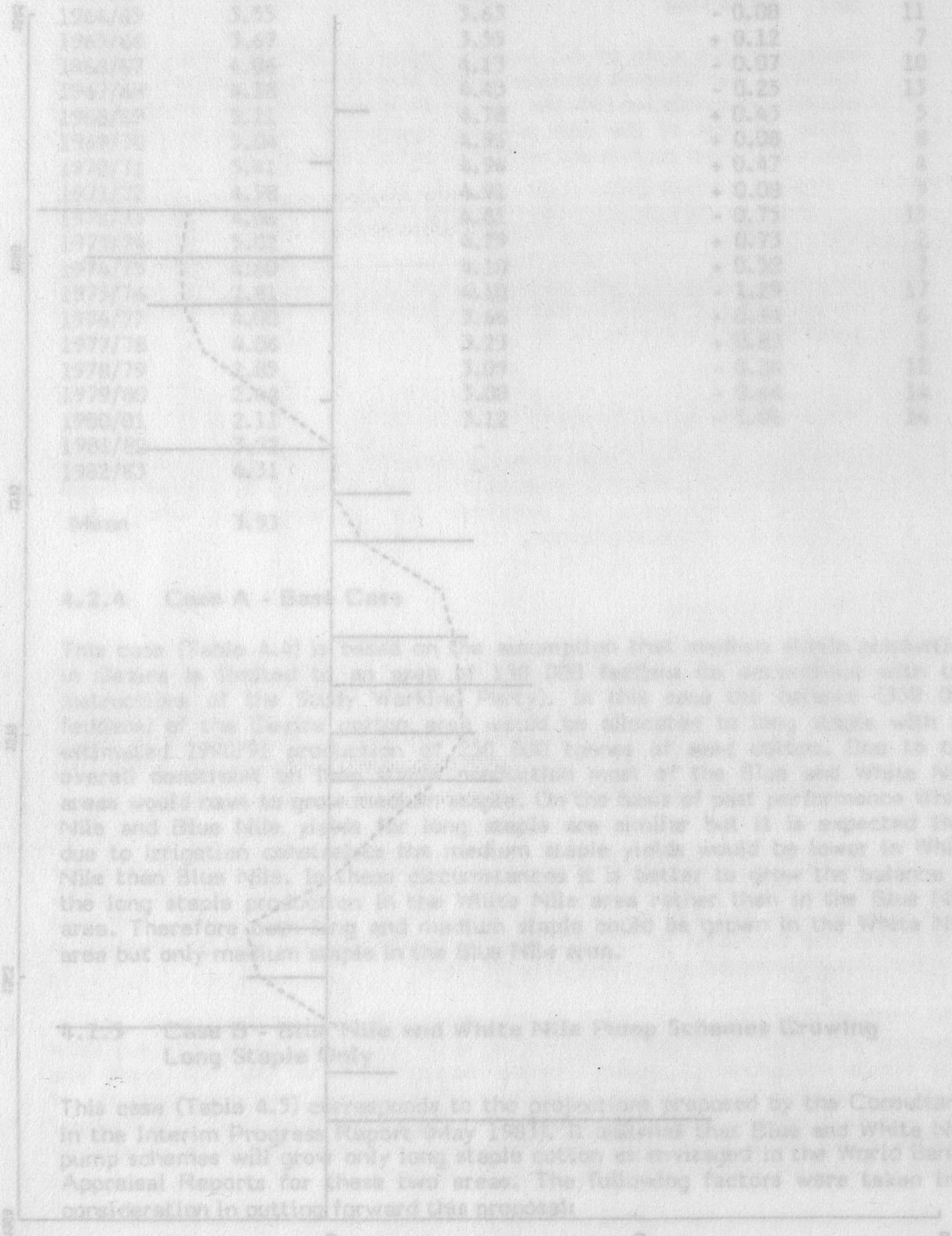
4.2.5 Case B - Blue Nile and White Nile Pump Schemes Growing Long Staple Only

This case (Table 4.5) corresponds to the projections proposed by the Consultants in the Interim Progress Report (May 1983). It assumes that Blue and White Nile pump schemes will grow only long staple cotton as envisaged in the World Bank's Appraisal Reports for these two areas. The following factors were taken into consideration in putting forward this proposal:

Figure 4.1

Annual Variation of Cotton Yield in the Gezira





(i) Medium staple is more sensitive to poor irrigation management, pest infestation and labour shortages than long staple. Medium staple should be restricted if possible to areas with more assured water supply and stronger management.

(ii) The past performance of medium staple in the pump schemes has been poor. Medium staple yields have been similar to or less than those for long staple.

(iii) Taking account of differences in ginning out-turn and lint price differentials medium staple needs to yield at least 10% higher than long staple to have an advantage.

(iv) Yields of medium staple in the Gezira are substantially greater than those in the pump schemes, the 1982/83 yield being about 2.5 kantars/feddan in the pump schemes compared with 5.9 kantars/feddan in Gezira. The differential for long staple is less, the yield in 1982/83 being about 2.75 kantars/feddan in the pump schemes compared with 4.3 kantars/feddan in the Gezira.

(v) The lint price for long staple is the same for lint from the pump schemes and from Gezira. The lint price for medium staple is less for lint from the pump scheme than for lint from Gezira.

(vi) It is considered preferable not to mix varieties within a production scheme if possible. The mixing of varieties complicates management of agricultural operations and processing.

(vii) It is considered that the management of the Gezira scheme is best able to handle a mix of medium and long staple and to meet the differing annual requirements for each that may occur.

(viii) Although rehabilitation of the pump schemes has been initiated it is considered that it will be some time before the necessary technical and managerial conditions will prevail to ensure the successful cultivation of medium staple.

(ix) As the total area of the Gezira is larger there is more scope for flexibility in the use of processing facilities to cope with varying proportions of long and medium staple production.

4.2.6 Case C - Blue and White Nile Pump Schemes Growing Medium Staple Only

In their comments on the Consultants Interim Progress Report, the Study Working Party stated that the minimum area of medium staple in Gezira should be 20 000 feddans. This would leave 480 000 feddans of cotton are to be planted with long staple which should given a seed cotton production in 1990/91 of 343 000 tonnes (equivalent to 610 000 bales of lint). This would almost certainly satisfy market demands for long staple in which case the whole of the cotton area of the pump schemes would be planted to medium staple. It is considered most unlikely that such an extreme case would occur in practice but it is useful nevertheless to consider this case to demonstrate the limits of the requirement for ginning facilities.

4.3 Ginning Season

4.3.1 Weekly Operation

The importance of planned routine maintenance has already been stressed in Chapter 2. Routine maintenance will provide increased efficiency, higher lint out-turns and improvements to grade. Good housekeeping and cleanliness in the ginning factory contribute to the production of good quality lint. Sufficient capacity should therefore be provided to allow the expected average crop to be ginned within a 6-day weekly working schedule, one day per week being given to thorough routine maintenance and cleaning.

All calculations of the nominal seasonal capacity of ginning factories have been based on a 6-day week. If there is a requirement for increased output to meet above average crop production, this can be provided by working additional shifts. A $6\frac{1}{2}$-day week will provide capacity to gin a production of 108% of the average, while a 7-day working week will increase capacity to 117% of the average. On the basis of the analysis given in Section 4.2.3, 7-day working could be expected about 1 year in 10, assuming that nominal capacity corresponds to average production. The possibility of working additional shifts also provides reserve capacity to cope with the operating contingencies.

4.3.2 Lengths of Ginning Season

The seasonal capacity of ginning factories is calculated from the number of days available for ginning the crop. This varies according to scheme and variety. The effective lengths of the ginning season which have been adopted for each scheme are summarised in Table 4.9 and are discussed below.

TABLE 4.9

Lengths of Ginning Season (effective working days)

Scheme	Long staple	Medium staple	Short staple
Gezira) Blue Nile/Suki) White Nile)	105	120	-
Rahad) New Halfa)	-	125	-
Northern (Zeidab)	105	125	-
Tokar (Port Sudan)	150	-	-
Nuba Mountains	-	-	90
MFC (Damazin)	-	-	100

(a) Gezira

Arrivals of medium staple seed cotton at the ginneries start in early to mid December and reach a peak towards the end of January. Most of the crop is received by mid-March. Arrivals of long staple start in late January; there is a more rapid build-up in the rate of arrivals to a peak at the end of February, but arrivals continue into May.

Ginning begins when there is a sufficient stock of a particular grade of seed cotton. In the case of medium staple, this should normally occur before the end of December. However, since medium staple forms only part of the total production, and in view also of the slow build-up of arrivals, there is inevitably some under-use of capacity during part of January. If a large proportion of medium staple is grown, all the factories should come into full production during January. However, if there is only a small proportion of medium staple, it will not be possible to bring all the factories into operation until long staple arrivals start to build up in early February.

The end of the ginning season is determined by the onset of the rains. Although the probabilities of rainfall vary at the different sites, the end of May is generally regarded by SGB as the target for completion of ginning. Completion of ginning by 31st May also satisfies statutory requirements relating to close season pest control regulations.

Strictly speaking, for the reasons indicated above, the effective length of the ginning season in terms of the equivalent number of working days at full production depends on the relative proportions of medium and long staple production. However, to avoid undue complication a standard length of ginning season has been adopted in determining the ginning capacity for all cases of the production projections. For medium staple, the effective length of the ginning season is taken as 120 working days, which compares with a total number of days between 1st January and 31st May of 129, with a 6-day week. For long staple, the figure of 105 days corresponds approximately to the period from 1st February to 31st May, with a 6-day week.

(b) Blue Nile/Suki and White Nile

On these schemes, the various production projections also include both medium and long staple varieties, and the same lengths of ginning season have been adopted as for Gezira.

(c) Rahad and New Halfa

Ginning must be confined to the period between 1st January and 31st May, and a December start to ginning cannot be counted upon. Allowing for a short build-up period at the beginning of January, the effective length of the season has been taken as 125 working days, with a 6-day week. The same figure has been adopted for the Northern Corporation ginnery at Zeidab.

(d) Tokar

The dry climatic conditions allow a long ginning season at Tokar of 150 working days.

(e) Nuba Mountains and Damazin

Because of the early onset of the rains, the ginning season is limited to a maximum of 90 working days. At Damazin, a slightly longer season of 100 days has been allowed.

4.4 Standard Lint Out-turns

Lint out-turns are not constant, and there are variations from year to year and from scheme to scheme. Variations can also be expected between different pickings. Early pickings can contain more moisture which is lost in pre-gin storage and in the ginning process. The middle crop is generally cleaner and drier and gives the best out-turn, while the top crop contains more trash and immature locks, and if ginned later may pick up moisture as natural humidity increases with the start of the rainy seasons.

For planning purposes the following standard lint out-turns have been used to relate lint output to seed cotton throughput:

Long staple	34%
Medium staple	37%
Short staple	33%

These figures include lugatta lint, but not scarto lint, which is ginned separately.

4.5 Assessment of Future Ginning Capacity

4.5.1 Capacities of Existing Ginneries

Table 4.10 shows the unit lint outputs and daily capacities for each existing ginning factory both under present conditions and following proposed rehabilitation and improvements. The unit lint outputs per gin stand are all given in terms of average output per gross gin-hour, i.e. allowing for non-productive time.

The following points should be noted:

(i) The present capacities are based on average conditions at the time of the study. It should be emphasised that performance could not necessarily be sustained at these levels in the future without adequate maintenance and considerable expenditure on spares and replacements. Indeed, in some cases a substantial decline in unit capacity could be expected, particularly if increased production resulted in greater pressure being put on the existing plant. In Annex 8, an attempt has been made to quantify possible decline in capacity in order to assess the benefits of rehabilitation for the financial and economic analysis.

(ii) The increases shown for SGB Factories Nr 4, 5, 6, 11, 12 and 14 are largely due to improvements planned under the GRP, with only a small part of the increase being attributable to the provision of blending halls under this project (see (v) below).

TABLE 4.10

Daily Capacities of Ginning Factories

	Medium/short staple						Long staple					
	Lint output (kg/gross gin-hour)		Lint output (bales/day/factory)(3)		Seed cotton throughput (tonnes/day/factory)		Lint output (kg/gross gin-hour)		Lint output (bales/day/factory)(3)		Seed cotton throughput (tonnes/day/factory)	
	Present	Future	Present	Future	Present	Future	Present	Future	Present	Future	Present	Future
Gezira(1)												
- Marangan Nr 1,2,3,4	23	29	266	337	137	174	34	40	394	461	221	259
- Marangan Nr 11	25	29	289	337	149	174	36	40	418	461	234	259
- Hasaheisa Nr 5,6	23	29	266	337	137	174	34	40	394	461	221	259
- Hasaheisa Nr 7,8	21	44	242	506	125	261	32	60	370	693	208	389
- Hasaheisa Nr 10	25	25	62	62	32	32	36	36	91	91	51	51
- Hasaheisa Nr 12	25	29	289	337	149	174	36	40	418	461	234	259
- Hasaheisa Nr 13	21	44	122	254	63	131	32	60	185	347	104	195
- Bageir Nr 14	25	29	314	366	162	189	36	40	452	502	254	282
Blue Nile/Suki												
- Sennar	24	26	180	198	93	102	33	36	249	274	140	154
- Hamadnallah	34	34	291	291	150	150	50	50	427	427	240	240
- Kassab Nr 1	16	44	130	374	67	193	21	60	171	513	96	288
- Kassab Nr 2	605	665	229	250	118	129	-	-	-	-	-	-
- Kassab Nr 3	1 173	1 173	442	442	228	228	-	-	-	-	-	-
White Nile												
- Dueim	39	39	235	235	121	121	50	50	301	301	169	169
- Kosti	33	33	200	200	103	103	49	49	296	296	166	166
- Rabak	29	44	364	506	188	261	40	60	502	755	282	424
Rahad - Fau Nr 1,2,3,4	997	1 173	376	442	194	228	-	-	-	-	-	-
New Halfa - Nr 1,2,3	880	968	331	364	171	188	-	-	-	-	-	-
Northern - Zeidab	24	24	120	120	62	62	-	-	-	-	-	-
Tokar - Port Sudan	-	-	-	-	-	-	32	32	160	160	90	90
Nuba Mountains(2)												
- Kadugli, Kalogi, Abu Gebeiha, Lagowa	295	324	149	162	86	94	-	-	-	-	-	-
- Umm Berembeita, Semeih, Dilling	290	440	145	111(4)	84	64(4)	-	-	-	-	-	-
- Talodi	300	330	114	124	66	72	-	-	-	-	-	-
MFC - Damazin(2)	1 320	1 320	373	498(5)	216	288(5)	-	-	-	-	-	-

Notes: (1) Future capacities include effects of improvements under GRP
(2) Short staple
(3) Based on standard 420 lb (191 kg) bale weight
(4) Number of gins reduced from four to two
(5) Increase due to improvement in electric power availability

(iii) The greatest increases in ginning capacity resulting from the project would occur at SGB Factories Nr 7, 8 and 13 (Hasaheisa), Kassab Factory Nr 1 and Rabak, where it is proposed to replace old Model 1 gins by improved roller gins of the type used in Egypt, with full mechanisation. Increases at these factories would be smaller if Model 2 gins were installed.

(iv) Increases in capacity at roller gin factories other than those in (iii) above are due mainly to:

- the effect of the seed cotton cleaning system in opening up to locks of cotton, which then gin more freely; this effect is particularly marked with medium staple cotton;

- where applicable, notably at SGB Factories Nr 1, 2 and 3, the effect of mechanisation in ensuring a steady supply of seed cotton to the gins.

Installation of new humidification systems also provides a slight increase in capacity, but the capacity effect of humidification is much less than in a saw ginnery.

(v) Provision of blending halls at the main roller gin factories also makes a contribution to increased capacity by ensuring a continuous supply of seed cotton. Where they are added to an existing mechanised factory, the capacity increase due to the blending halls alone has been taken as about 4% for the purpose of assessing project benefits.

(vi) The capacity increases at Kassab Factory Nr 2, New Halfa and Nuba Mountrains are due to the addition of humidification systems, which should reduce downtime.

(vii) At the Rahad ginneries, the capacity increase corresponds to restoration of the average unit production which was achieved after commissioning in 1978.

(viii) At Umm Berembeita, Dilling and Semeih, the future capacity relates to the 2 new gin stands proposed at each ginnery. Future capacity would be greater if two of the four existing gins were retained, but the remaining serviceable life of these is limited, and in any case it is expected that the capacity of the new gin stands would be adequate for future crop production.

(ix) Present capacity at Damazin is based on an 18-hour day, as power to the ginnery is cut off for 6 hours per day (see Chapter 6). Future capacity is based on the assumption that present power supply problems will be resolved; the increase is not attributable to this project.

Table 4.11 summarises the future daily ginning capacities by production scheme. Where both medium and long staple capacities are shown for roller ginning facilities, the figures given are the respective total capacities assuming only one type of cotton is processed.

TABLE 4.11

Future Ginning Capacities by Scheme

Scheme	Type of gin	Daily capacity (tonnes of seed cotton) Medium/short staple	Daily capacity (tonnes of seed cotton) Long staple	Seasonal capacity[1] ('000 tonnes of seed cotton) Medium/short staple	Seasonal capacity[1] ('000 tonnes of seed cotton) Long staple	Seasonal capacity[1] ('000 bales of lint)[4] Medium/short staple	Seasonal capacity[1] ('000 bales of lint)[4] Long staple
Gezira	Roller[2]	2 266	3 378	272	355	527	632
	Saw	500[3]	-	60	-	116	-
Blue Nile/Suki	Roller[2]	445	682	53	72	103	128
	Saw	357	-	43	-	83	-
White Nile	Roller[2]	485	724	58	76	112	135
Rahad	Saw	913	-	114	-	221	-
New Halfa	Saw	564	-	71	-	138	-
Northern	Roller	56	-	7	-	14	-
Tokar	Roller	-	81	-	12	-	21
Nuba Mountains	Saw	602	-	54	-	93	-
Damazin	Saw	288	-	29	-	50	-

Notes : (1) Based on 6-day week.
(2) Figures for roller gin capacities indicate alternatives for either medium or long staple processing.
(3) Capacity of 2 new saw gin factories to be provided under Gezira Rehabilitation Project.
(4) Based on standard 420 lb (191 kg) bale weight

4.5.2 Comparison of Projected Production and Ginning Capacity

The estimated production of seed cotton in 1984/85 and 1990/91 for each projection case is compared in Table 4.12 with the capacities of the existing ginneries after completion of proposed improvements. The capacities of 2 new saw gin factories at Marangan, which it is assumed will be provided under the Gezira Rehabilitation Project, have also been taken into account. For schemes where both long and medium staple cotton is ginned on roller gins, the available capacity for ginning medium staple cotton has been calculated after allowing for ginning of all the long staple production. All the ginning capacities are based on the lengths of ginning season given in Table 4.9, i.e. with a 6-day week.

It can be seen from Table 4.12 that with a 6-day week there will be future shortfalls in capacity in a number of instances. The projected shortfalls are summarised in Table 4.13. The situation for each scheme is discussed below.

TABLE 4.13

Projected Shortfalls in Ginning Capacity (1990/91)

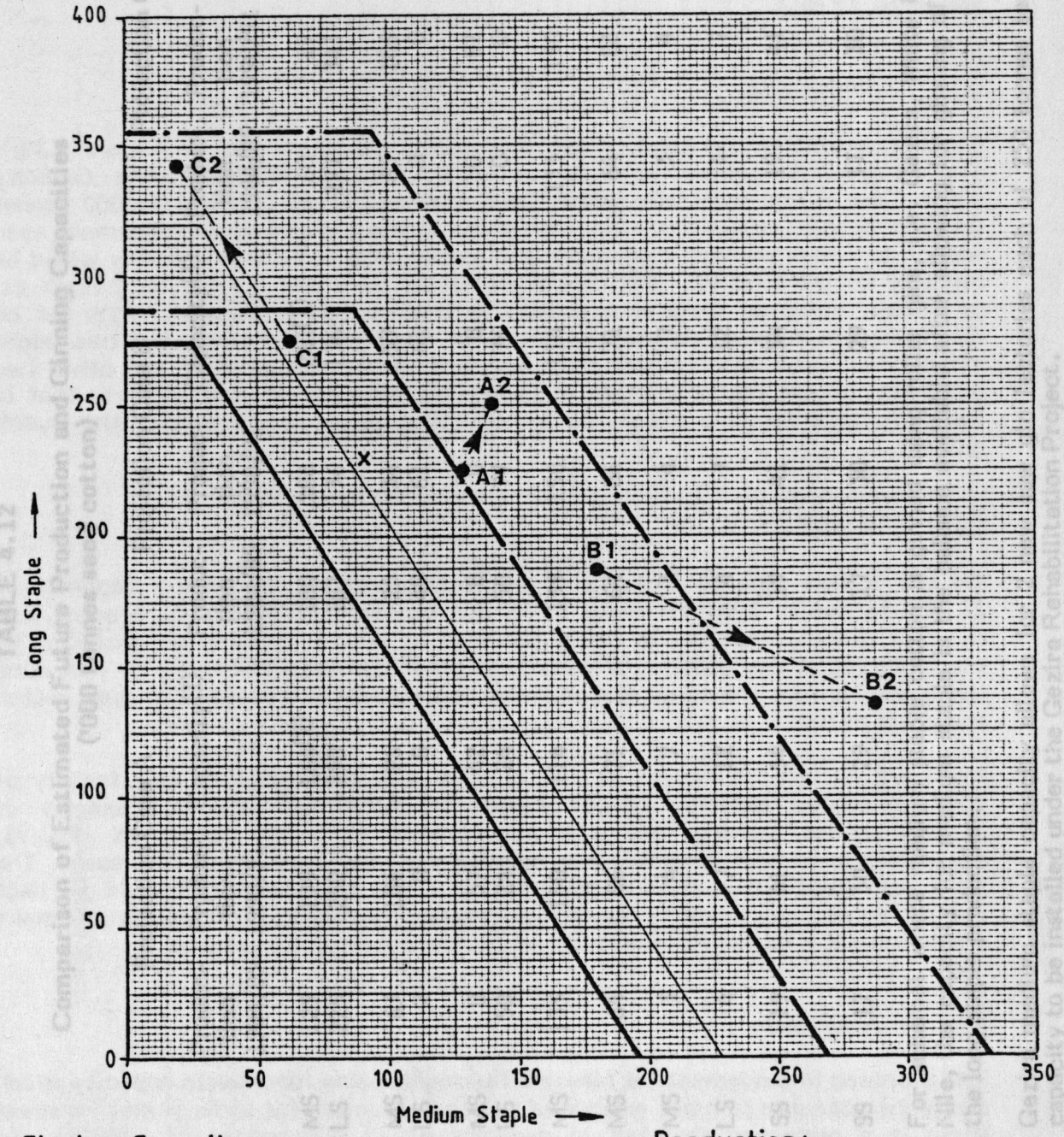
Corporation/area	Shortfall in capacity (1990/91) (tonnes seed cotton/year)		
	Case A	Case B	Case C
Gezira	-	47 000	-
Blue Nile/Suki	10 000	-	10 000
White Nile	15 000	-	24 000
Rahad	36 000	36 000	36 000
New Halfa	15 000	15 000	15 000
Northern	-	-	-
Tokar	-	-	-
Nuba Mountains	-	-	-
MFC	1 000	1 000	1 000

(a) Gezira

The comparison of ginning capacities and seed cotton production is illustrated graphically in Figure 4.2. Under Cases A and C, future ginning capacity is sufficient to meet projected production in 1990/91. However, under Case B there is a shortfall of 47 000 tonnes of medium staple capacity in 1990/91. This is due to the effect of the large proportion of medium staple production on the capacity of the roller gin installations. To meet the shortfall would require 7 day/week working throughout the season. If one additional new factory were provided, with a capacity of 250 tonnes/day (medium staple), the whole of the projected 1990/91 crop could be ginned with an average 6.35 day/week working. Moreover with an increasing proportion of medium staple cotton, the effective length of the ginning season should tend to increase as a result of higher utilisation of ginning capacity in January. For instance, an extension of 5 days would provide an additional 14 000 tonnes capacity. The need for second additional factory to maintain 6 day/week working is therefore marginal.

Figure 4.2

Annual Ginning Capacities and Seed Cotton Production - Gezira (' 000 Tonnes Seed Cotton)



Ginning Capacity:

7-day week / 6-day week

- Existing
- With 2 new saw gin factories and improvements under G.R.P.
- After Proposed Improvements

Production:

- X - 1982/83
- 1 - 1984/85
- 2 - 1990/91
- A - Case A
- B - Case B
- C - Case C

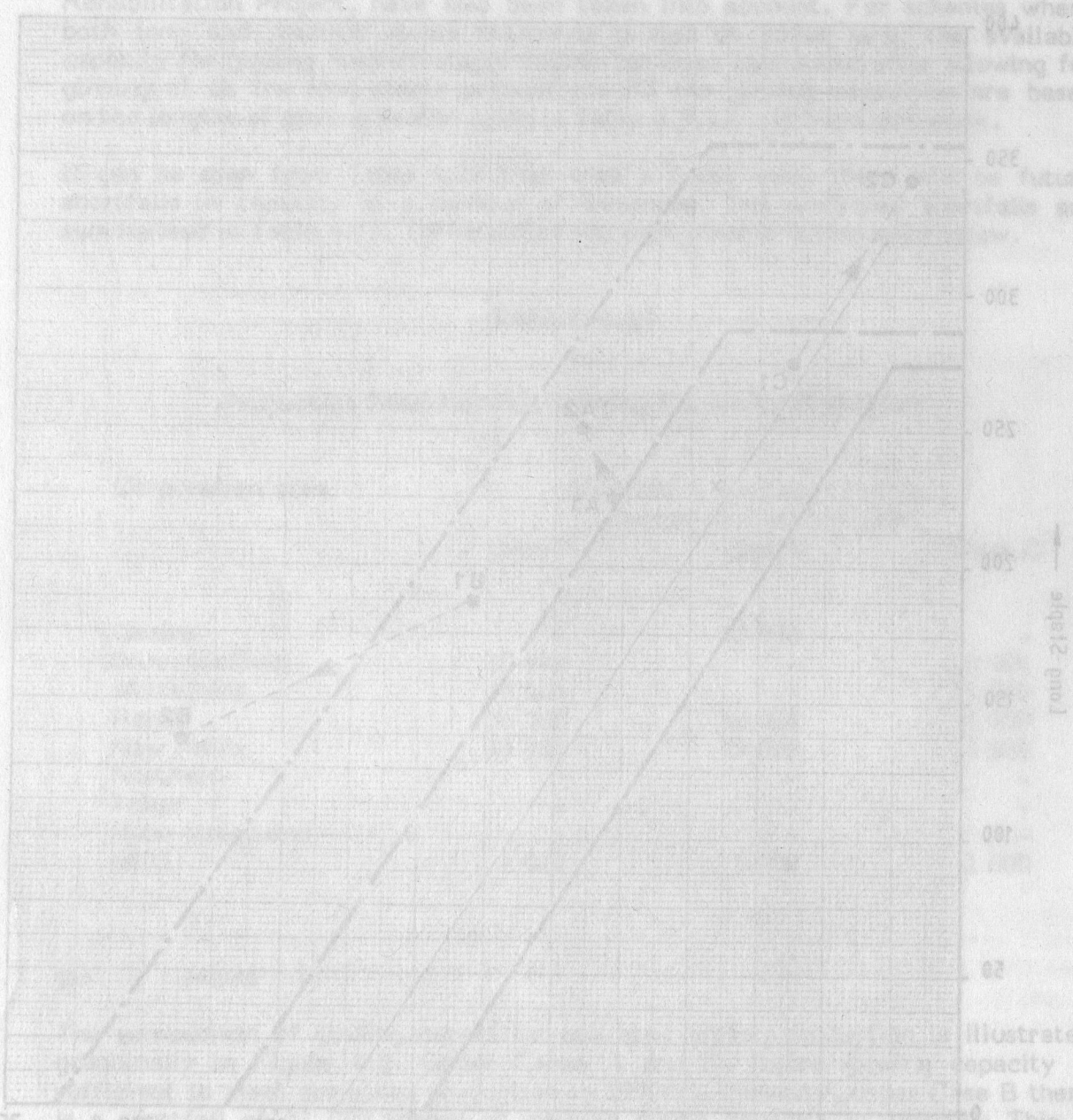


TABLE 4.12

Comparison of Estimated Future Production and Ginning Capacities ('000 tonnes seed cotton)

Corporation/ area		Projection Case A			Projection Case B			Projection Case C		
		Production 1984/85	Production 1990/91	Capacity[1]	Production 1984/85	Production 1990/91	Capacity[1]	Production 1984/85	Production 1990/91	Capacity[1]
Gezira	MS	129	139	164[2]	180	288	241[2]	60	19	102[2]
	LS	225	250	250	187	136	136	277	343	343
Blue Nile/ Suki	MS	63	106	96	25	34	57	65	106	96
	LS	2	0	0	40	61	61	0	0	0
White Nile	MS	0	57	42	0	0	0	50	82	58
	LS	50	24	24	50	77	76	0	0	0
Rahad	MS	135	150	114	135	150	114	135	150	114
New Halfa	MS	64	86	71	64	86	71	64	86	71
Zeidab	MS	3	4	7	3	4	7	3	4	7
Tokar	LS	4	7	12	4	7	12	4	7	12
Nuba Mountains	SS	19	41	54	19	41	54	19	41	54
MFC	SS	17	30	29	17	30	29	17	30	29

Notes: (1) For schemes where medium staple cotton is ginned using roller gins, i.e. Gezira, White Nile and Blue Nile, the capacity for medium staple is the balance available after allowing for ginning of the whole of the long staple production.

(2) Gezira medium staple capacity allows for 2 new saw gin factories each of 250 tonnes seed cotton/day capacity to be installed under the Gezira Rehabilitation Project.

(b) Blue Nile/Suki

Ginning capacities and seed cotton production are illustrated on Figure 4.3(a). For this area, capacity is adequate for projected 1990/91 production under Case B, but there is a shortfall of 10 000 tonnes (medium staple) under Cases A and C. To meet this shortfall without additional ginning facilities would require either an average 6.6 day/week working or an extension of the ginning season by 12 days.

(c) White Nile

Ginning capacities and seed cotton production are illustrated on Figure 4.3(b). The situation is similar to that for Blue Nile/Suki, with adequate capacity under Case B and shortfalls under Case A and C of 15 000 and 24 000 tonnes (medium staple) respectively. In both these cases a shortfall would remain even with 7 day/week working throughout the season, and additional capacity would be required before 1990/91. This should preferably be a saw gin factory near Kosti or Rabak. However there is a possibility that cotton production might not be distributed in relation to the capacities of the three ginneries, and this might affect the Dueim area in particular which is rather distant from the other two ginneries. Should the production at Dueim increase out of proportion to that in the pump schemes as a whole, there might also be a need to enlarge the Dueim ginnery.

(d) Rahad

On the Rahad scheme there is a projected shortfall in ginning capacity of 21 000 tonnes in 1984/85 rising to 36 000 tonnes in 1990/91. At present, the required ginning capacity is being provided by almost continuous operation of the factories at the expense of deterioration of the machinery, and by operating the ginneries into the rainy season, with consequent rain damage to seed cotton and bales of lint.

The need for a fifth factory at Fau is clear and immediate. A new factory of 250 tonnes/day capacity would provide an additional seasonal capacity of 31 000 tonnes, leaving only a small shortfall of 5 000 tonnes in 1990/91, equivalent to an additional 0.2 days working per week throughout the season. The long term need for a sixth factory is therefore marginal, but should be kept under review, particularly as some reserve capacity is required to make allowance for a late start to ginning, which has occurred frequently.

(e) New Halfa

The proposed improvements at New Halfa provide some increase in capacity which should be adequate to meet estimated future production for some years. However there is a projected shortfall in capacity of 15 000 tonnes by 1990/91. To maintain 6-day week working a fourth factory similar to the existing three would be required by about 1987/88. However the production projections are based on increases in both yields and area under cotton, to be achieved through rehabilitation programmes in progress, and are subject to some uncertainty.

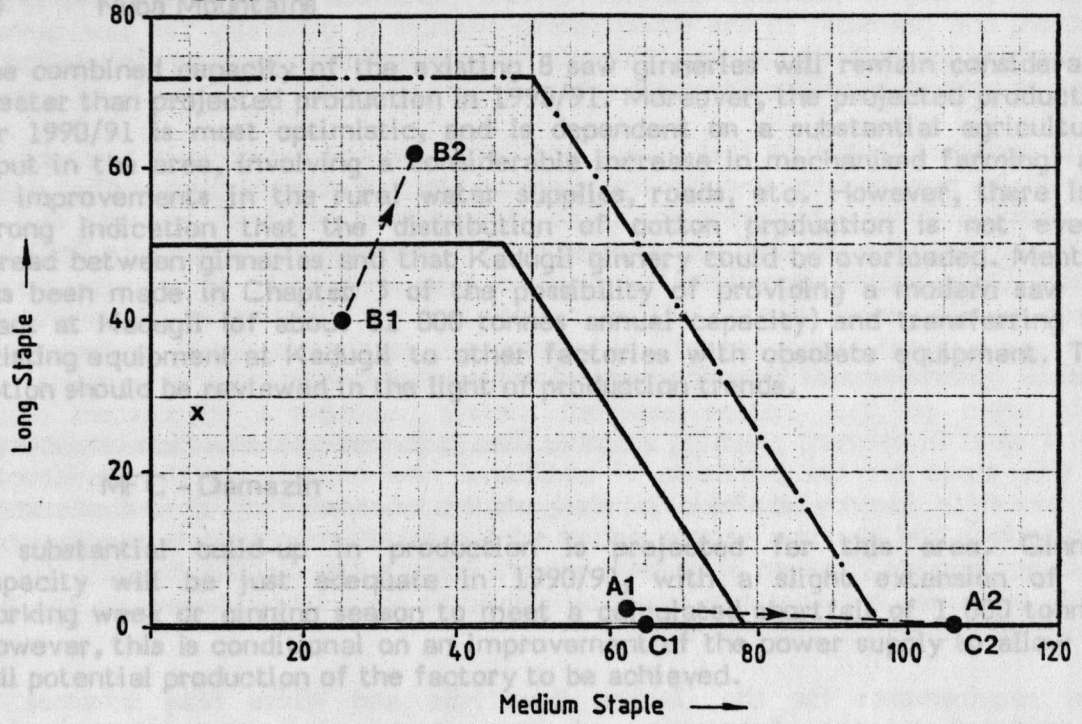
(f) Northern Corporation - Zeidab

Capacity at Zeidab is more than adequate to meet projected production.

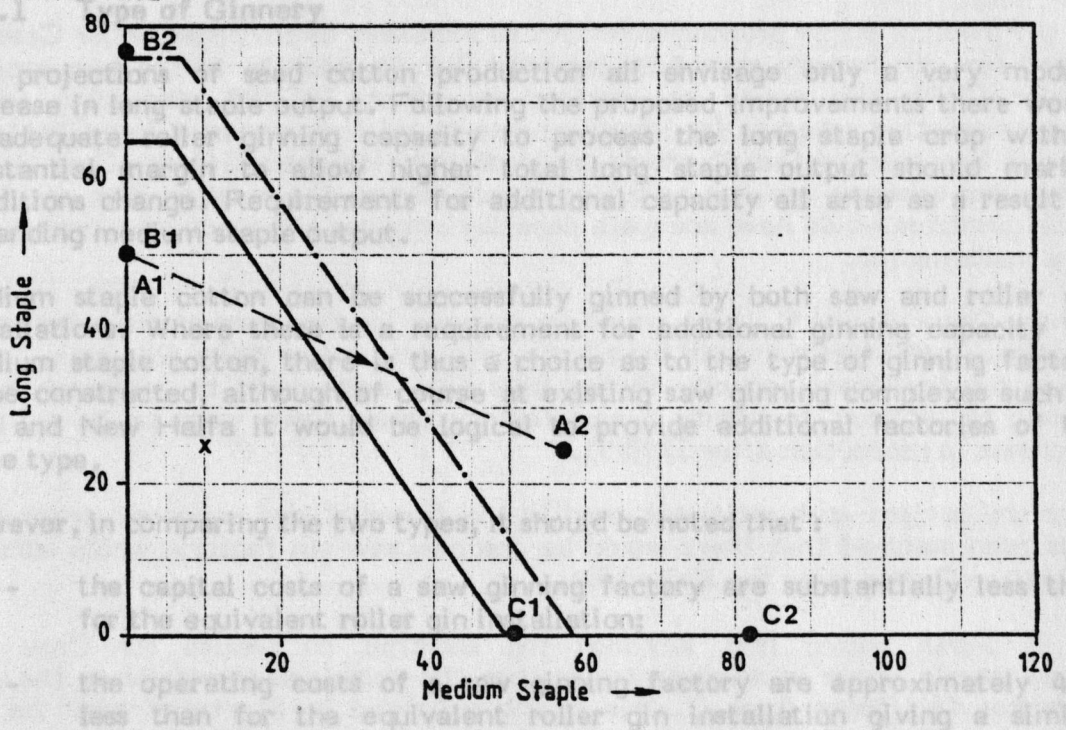
Figure 4.3.

Annual Ginning Capacities and Seed Cotton Production - Blue and White Niles ('000 Tonnes Seed Cotton)

(a) Blue Nile/Suki



(b) White Nile



Ginning Capacity:

(6 day week)

Existing

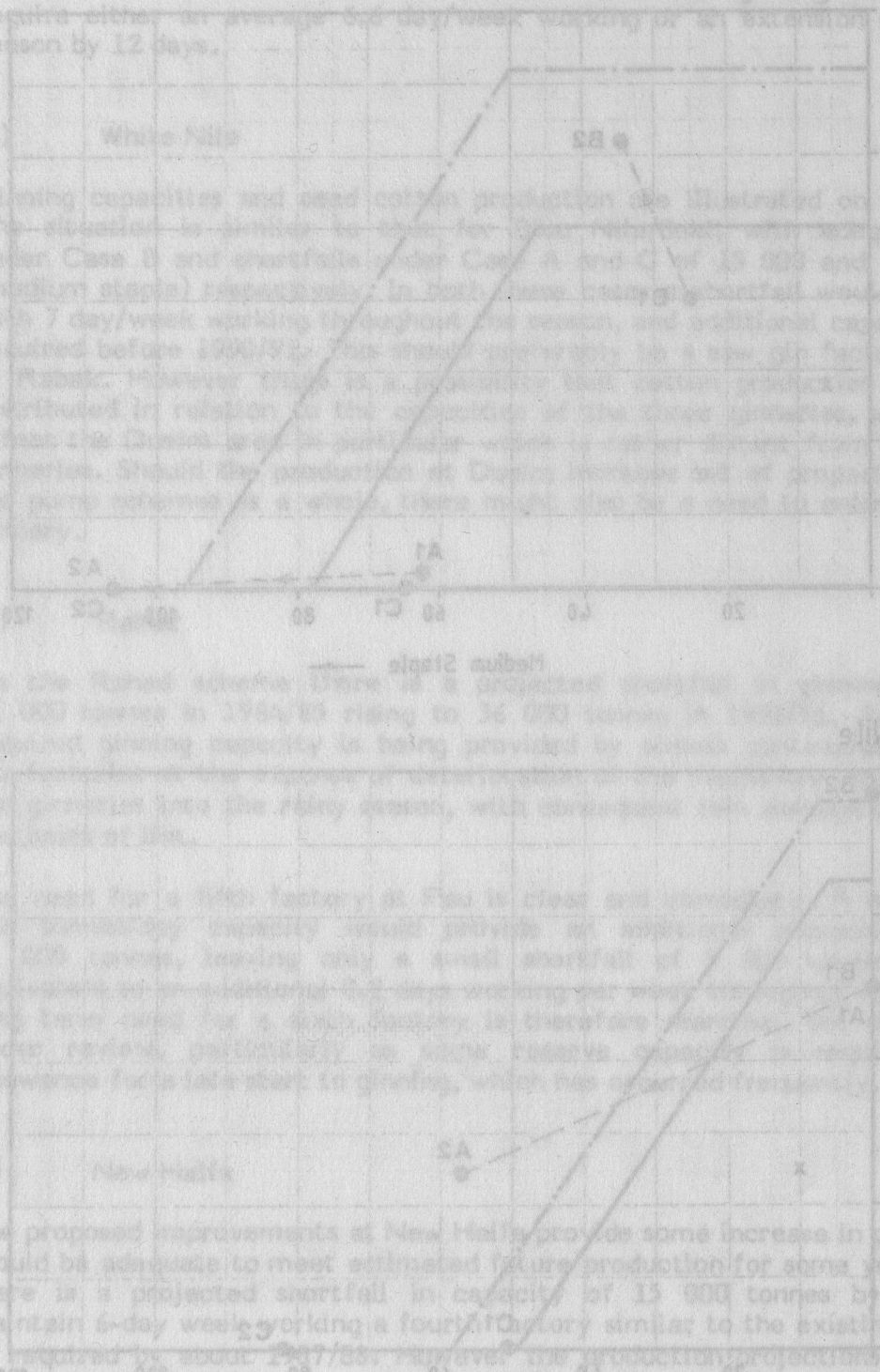
After Proposed Improvements

Production:

X - 1982/83 A - Case A

1 - 1984/85 B - Case B

2 - 1990/91 C - Case C



(a) Blue Nile/Suki

Ginning capacities and seed cotton production are illustrated on Figure 4.3(a). For this area, capacity is adequate for projected 1990/91 production under Case B but there is a shortfall of 10 000 tonnes (medium staple) under Cases A and C. To meet this shortfall without additional ginning facilities would require either an average 6.6 day/week working or an extension of the ginning season by 12 days.

(b) White Nile

Ginning capacities and seed cotton production are illustrated on Figure 4.3(b). The situation is similar to that for Blue Nile/Suki, with adequate capacity under Case B and shortfalls under Case A and C of 15 000 and 24 000 tonnes (medium staple) respectively. In both these cases a shortfall would remain even with 7 day/week working throughout the season, and additional capacity would be required before 1990/91. This should preferably be a new gin factory near Kosti or Rabak. However there is a possibility that cotton production might not be distributed in relation to the capacities of the three ginneries, and this might affect the Dueim area in particular where is rather distant from the other two ginneries. Should the production at Dueim increase out of proportion to that in the pump scheme as a whole, there might also be a need to enlarge the Dueim ginnery.

(c) Rahad

On the Rahad scheme there is a projected shortfall in ginning capacity of 21 000 tonnes in 1984/85 rising to 36 000 tonnes in 1990/91. In [illegible] the required ginning capacity is being provided by [illegible] of the [illegible] of the expense of deterioration of the [illegible] by operating the ginneries into the rainy season, with consequent [illegible] seed cotton [illegible].

The need for a fifth factory at Fau is clear and [illegible] factory of [illegible] capacity would provide an [illegible] capacity of 31 000 tonnes, leaving only a small shortfall of [illegible] tonnes in 1990/91, [illegible] working per week throughout the season. The long term need for a sixth factory is therefore [illegible] should be kept under review, particularly as some reserve capacity is required to make allowance for a late start to ginning, which has occurred frequently.

(d) New Halfa

The proposed improvements at New Halfa provide some increase in capacity which should be adequate to meet estimated future production for some years. However there is a projected shortfall in capacity of 15 000 tonnes by 1990/91. To maintain 6-day week working a fourth factory similar to the existing three would be required by about 1987/88. However the production projections are based on increases in both yields and area under cotton, to be achieved through rehabilitation programmes in progress, and are subject to some uncertainty.

(f) Northern Corporation - Zeidab

Capacity at Zeidab is more than adequate to meet projected production.

(g) Tokar

Port Sudan ginnery has substantial spare capacity at present, and capacity will remain adequate even with a significant increase in production by 1990/91.

(h) Nuba Mountains

The combined capacity of the existing 8 saw ginneries will remain considerably greater than projected production in 1990/91. Moreover, the projected production for 1990/91 is most optimistic, and is dependent on a substantial agricultural input in the area, involving a considerable increase in mechanised farming, and on improvements in the rural water supplies, roads, etc. However, there is a strong indication that the distribution of cotton production is not evenly spread between ginneries and that Kadugli ginnery could be overloaded. Mention has been made in Chapter 3 of the possibility of providing a modern saw gin plant at Kadugli (of about 12 000 tonnes annual capacity) and transferring the existing equipment at Kadugli to other factories with obsolete equipment. This option should be reviewed in the light of production trends.

(i) MFC - Damazin

A substantial build-up in production is projected for this area. Ginning capacity will be just adequate in 1990/91, with a slight extension of the working week or ginning season to meet a calculated shortfall of 1 000 tonnes. However, this is conditional on an improvement of the power supply to allow the full potential production of the factory to be achieved.

4.6 Recommendations for Additional Ginning Capacity

4.6.1 Type of Ginnery

The projections of seed cotton production all envisage only a very modest increase in long staple output. Following the proposed improvements there would be adequate roller ginning capacity to process the long staple crop with a substantial margin to allow higher total long staple output should market conditions change. Requirements for additional capacity all arise as a result of expanding medium staple output.

Medium staple cotton can be successfully ginned by both saw and roller gin installations. Where there is a requirement for additional ginning capacity for medium staple cotton, there is thus a choice as to the type of ginning factory to be constructed, although of course at existing saw ginning complexes such as Fau and New Halfa it would be logical to provide additional factories of the same type.

However, in comparing the two types, it should be noted that :

- the capital costs of a saw ginning factory are substantially less than for the equivalent roller gin installation;
- the operating costs of a saw ginning factory are approximately 40% less than for the equivalent roller gin installation giving a similar output;
- there is no significant difference in prices for saw and roller ginned medium staple.

It is sometimes claimed that roller ginned medium staple lint sells for a premium compared to the equivalent saw ginned lint. In the Sudan the only scheme where the same cotton is both saw ginned and roller ginned is Suki. Recent prices for Suki indicate a small premium of US cent 1 per lb in favour of roller ginned lint. However, though there is a certain sector of the textile industry willing to pay a premium because of the particular nature of roller ginned cotton, the premium in the international market is generally for saw ginning. This premium amounts to some US cents 5 per lb in Turkey where both methods of ginning are employed for the same cotton.

It is proposed therefore that where additional ginning capacity is required this should be provided by saw gin installations. It is further proposed that as far as possible ginning factories should be standardised and that any new saw gin factories should be of 250 tonnes seed cotton/day capacity (similar to Fau, New Halfa, Damazin and Kassab Nr 3).

4.6.2 Summary of Requirements for New Factories

In terms of investment planning the only firm recommendation which can be made at this stage for the provision of additional new capacity is the construction of the fifth factory at Fau. In view of the uncertainties of the production projections and the less urgent nature of the requirements, it is recommended that no decision is taken at present on providing extra ginning capacity for the other schemes, but that the situation should be kept under review in the light of actual production achievements.

The requirements for the Gezira, Blue Nile and White Nile schemes are interrelated by the distribution of long staple production between these schemes, and therefore differ for each case of projected production.

If the medium staple production on Gezira increases as envisaged under Case B, a third saw gin factory should be provided (i.e. in addition to the two proposed under GRP); this would be required by about 1987/88, depending on the implementation schedule for improvements at existing ginneries (see Chapter 7), and it is suggested that it should be located at Hasaheisa. Under Case B, with the pump schemes growing only long staple cotton, the existing Blue and White Nile ginneries would have adequate capacity provided the proposed improvements are implemented.

Under Cases A and C, there would be no need for the third saw gin factory on Gezira. A new factory would have to be provided for the White Nile area, but the need for additional capacity in the Blue Nile area would be marginal, and it would be difficult to justify a new factory unless there were to be a further increase in production after 1990/91.

For the project cost estimates used in the financial and economic analyses, it has been assumed that there would be one new saw gin factory, which would be either on Gezira or on the White Nile.

It is worth noting that although the shortfall on Gezira for Case B is considerably larger in absolute terms than the combined shortfalls on the pump schemes for Cases A or C, this is not reflected in a greater need for new capacity. This illustrates the advantages of concentrating medium staple production on Gezira, where the large existing ginning capacity provides a greater flexibility for handling increased medium staple production.

4.6.3 Fau - Factory Nr 5

It is recommended that the new Factory Nr 5 at Fau should be similar to the existing factories but to a reduced specification. In particular, expensive items such as auto gin breast throwouts should not be included and it is proposed to provide a battery lint cleaner rather than the unit cleaners at existing factories.

A list of the proposed equipment to be installed in the new factory is given in Table 4.15. Costs of buildings and infrastructure are given in Table 4.15.

4.6.4 Standard New Saw Gin Factory

A list of recommended equipment for a standard new 3 gin stand saw gin factory with a capacity of 250 tonnes seed cotton/hour is given in Table 4.16. Such a factory would be suitable for installation on the Gezira, Blue Nile or White Nile schemes. It has already been suggested in Chapter 2 that the two new saw gin factories to be built at Marangan under the Gezira Rehabilitation Project should incorporate a moduling system for seed cotton, and the costs of a moduling system have also been included in Table 4.16.

Costs of buildings and infrastructure are given in Table 4.17.

TABLE 4.14

Costs of Proposed Equipment for New Factory Nr 5 at Fau

Item	Unit FE cost (US$ '000)	Nr required	FE cost (US$ '000)	Total cost (LS '000)
1. Seed cotton unloading system	110	1	110	223
2. Double suction fans	15	1	15	31
3. Inclined cleaner system	56	2	112	228
4. Conveyor distributor system including overflow pen and separator	67	1	67	137
5. 3 x 142 - 18" Murray gin stands less auto throwout and feeds	58.7	3	176	359
6. Feeders/extractors	39.7	3	119	242
7. Lint flue system	21	1	21	43
8. Battery condenser	48	1	48	97
9. Battery lint cleaner	115	1	115	234
10. Bale press	392	1	392	798
11. Lint moisture unit	6	1	6	12
12. Trash handling system	15	1	15	31
13. Seed handling system	35	1	35	71
14. Humidification system	55	1	55	113
15. Motors, starters, console, lighting	314	Sum	314	639
16. Trash cyclone	40	1	40	81
17. Seed bagging equipment	103	1	103	209
18. Miscellaneous	10	Sum	10	20

TABLE 4.15

Costs of Buildings and Infrastructure for New Factory Nr 5 at Fau

Item	FE cost (US $'000)	Total cost (LS '000)
Factory buildings (with dimensions)		
1. Main building (55 m x 15 m)	102	259
2. Power room (15 m x 8.5 m)	16	40
3. Mixing room (24 m x 15 m)	45	113
4. Seed room (18 m x 10 m)	22	57
Infrastructure(1)		
5. Hardstandings (4 Nr)	19	61
6. Stillage	-	54
7. Roads	35	113
8. Firefighting system		
- Tank (50 000 l)	18	39
- Hydrant system (30 Nr hydrants)	94	217
9. Houses (31 Nr)	257	835

Note : (1) For details of infrastructural works see Chapter 5.

TABLE 4.16

Costs of Equipment for Standard New Saw Gin Factory

Item	FE cost (US$ '000)	Total cost (LS '000)
1. Seed cotton unloading and feeding system	109	222
2. Seed cotton cleaning group	196	399
3. Conveyor distributor	26	53
4. Ginning system	269	548
5. Submerged lint flue	21	42
6. Riser section and battery condenser	58	117
7. Baling press	338	686
8. Bale conveyor and scale	24	48
9. Seed transport system	84	171
10. Trash system and cyclones	101	205
11. Motors, console, starters, lighting	313	636
12. Piping and transitions	15	31
13. Seed cotton and lint humidification system	55	113
14. Module handling system	224	506
15. Module building system	78	177
16. Lint cleaning system (alternative options)		
- Air stream lint cleaners (3 Nr)	66	134
- Unit saw type lint cleaners (3 Nr)	143	291
- Battery saw type lint cleaner (1 Nr)	115	234

TABLE 4.17

Costs of Buildings and Infrastructure for New Saw Gin Factory

Item	FE cost (US $'000)	Total cost (LS '000)
Factory buildings (with dimensions)		
1. Main building (55 m x 15 m)	102	259
2. Power room (15 m x 8.5 m)	16	40
3. Mixing room (24 m x 15 m)	45	113
4. Seed room (18 m x 10 m)	22	57
5. Offices (200 m^2)	27	88
6. Small stores (2 Nr 24 m x 9 m)	54	136
7. Workshop	6	21
Infrastructure(1)		
8. Hardstandings (4 Nr)	19	61
9. Roads	46	150
10. Fencing (2 250 m)	10	31
11. Firefighting system		
- Tank (50 000 l)	18	39
- Hydrant system (33 Nr hydrants)	125	288
12. Houses (31 Nr)	257	835

Note : (1) For details of infrastructural works see Chapter 5.

CHAPTER 5

INFRASTRUCTURE

5.1 Introduction

5.1.1 General

This chapter covers the infrastructure aspects of the ginneries. It gives details of options considered and the bases on which outline designs and cost estimates have been prepared. In this connection infrastructure includes the following ginnery facilities :

- water supply for firefighting;
- water supply for domestic purposes;
- hardstandings;
- access roads;
- housing;
- fencing;
- sewage disposal;
- surface drainage.

5.1.2 Basis for Cost Estimates

The costs of civil works and materials are based on up to date contract construction rates collected during the programme of inventory visits. It was found that there was little variation between rates at different locations and therefore average rates have been adopted for all works. The foreign exchange component of locally quoted rates has been assumed to be 40%. The foreign exchange costs of imported items such as structural steel and mechanical equipment are based on recent quotations (CIF Port Sudan) obtained from manufacturers and suppliers. These have been checked wherever possible against actual past contract prices allowing for such factors as inflation and differences in specification.

A list of leading rates and prices used in preparing the estimates is given in Table 5.1. Details of taxes and duties are included in Annex 8.

5.2 Water Supply for Firefighting

5.2.1 Standards

Water should be available at all times at ginneries for firefighting purposes. It is considered that the minimum volume of water immediately available at each ginning factory for firefighting purposes should be some 150 m^3. This is sufficient for firefighting from two locations (25 l/s each) for 45 minutes. At

TABLE 5.1

Unit Rates and Prices for Civil and Building Works

Item		Unit	Rate LS
GENERAL RATES			
Excavation		m^3	7
Selected fill		m^3	7.5
Mass concrete		m^3	200
Concrete in roads and floor slabs		m^3	250
Reinforced concrete (including formwork)		m^3	350
Reinforcement		t	2 170
Fence		m	13.5
Steel pipe 150 mm diameter (including laying)		m	75
Fire hydrant (including installation)		Nr	1 350
GCI sheeting		m^2	11.5
Concrete pipe 400 mm diameter		m	25
Gravel for roads (including compaction)		m^3	25
Double bitumen surface dressing		m^2	20
Single brickwork		m^2	25
Housing and office buildings		m^2	350
OFFSHORE ITEMS			Price US$ CIF Port Sudan
Structural steelwork (per tonne)			1 100
Structural steelwork and cladding for 7 m high building (per m^2)			87
Pump (50 m^3/h)			1 850
Sectional steel elevated tank capacity	50 m^3		18 000
	100 m^3		24 000
	150 m^3		32 000
Packaged water treatment plant	5 m^3/h		62 000
	10 m^3/h		76 000

ginneries where less than this volume of water is always available additional storage is required. In order to provide maximum security of supply it is recommended that any new storage is provided in high level tanks.

Two systems of water distribution within ginnery factory yards are used at present; either a system of hydrants or a series of small ground tanks from which water is pumped by fire tender. At some ginneries neither hydrants nor ground tanks are provided as the distribution system is inadequate. In these cases it is recommended that a full hydrant system is installed. Where a hydrant system is used it is recommended that a minimum of 50 m^3 high level storage is provided to ensure adequate pressure at all times.

5.2.2 Works Required

The present status of water supply systems for ginnery firefighting is summarised in Table 5.2 (see Annex 1 for detailed inventories). The works required to bring ginneries up to the standards described above are given in Table 5.3, together with the estimated costs.

For the purpose of estimating costs it is assumed that the high level tanks are 18 m high sectional steel tanks supported on a steel framework. Water is delivered to the high level tank by means of electrically powered 50 m^3/h capacity pumps. The hydrant distribution system comprises 150 mm diameter steel pipes with, on average, one hydrant provided per 7 225 m^2 of ginnery yard.

At the SGB ginneries, the existing systems of fire canals and ground tanks are adequate, but additional firefighting equipment is required. A list of the proposed equipment with estimated costs is given in Table 5.4. It should be noted that although the cost estimates for the Gezira Rehabilitation Project include general provision for improvement of factory and yard infrastructure, there appears to be no specific provision for firefighting equipment other than in the new saw gin factories.

5.3 Water Supply for Domestic and Other Uses

5.3.1 Standards

Water is required for domestic purposes, i.e. drinking, washing, cooking, etc. and for humidification, cooling and cleaning in the ginning factories.

The water demand for a typical ginning factory is estimated as follows :

	litres/day
Humidification	6 000
Staff demands : 300 persons per shift x 2 shifts/day x 50 l/head	30 000
Allowance for leakage, wastage, other uses	10 000
Total	46 000
say, 50 000 l/d nominal	

TABLE 5.2

Present Status of Water Supply for Firefighting

Ginnery	Water source	Storage (gallons) ground	Storage (gallons) elevated	Hydrant system	Comment
Marangan	Fire canal and 2 wells for factory 11 sprinklers	52 Nr x 5 000 in factory yard	3 Nr x 12 000 1 Nr x 24 000 for sprinklers	No	Adequate
Hasaheisa	Fire canal and 2 wells for factory 12 sprinklers	52 Nr x 5 000 in factory yard	4 Nr x 12 000 1 Nr x 24 000 for sprinklers	No	Adequate
Bageir	Fire canal and 2 wells for factory sprinklers	10 Nr x 5 000 in factory yard	1 Nr x 24 000 for sprinklers	No	Adequate
Sennar	Municipal supply (unreliable)	1 Nr x 3 500	-	No	Inadequate storage and hydrants
Hamadnallah	Fire canal	-	1 Nr x 30 000 (only for buildings)	No	Adequate (no hydrants but good fire canal)
Kassab	Well	-	1 Nr x 17 000	Part	Inadequate storage and hydrants
Dueim	Adjacent irrigation canal	1 Nr x 11 000	1 Nr x 16 000	Yes	Adequate
Kosti	Municipal supply	2 Nr x 4 000	-	No	Inadequate storage and hydrants
Rabak	Municipal supply and direct from Nile	1 Nr x 140 000	-	Part	Needs high level storage and more hydrants
Fau	Fire canal	1 Nr x 80 000	2 Nr x 128 000	Yes	Adequate
New Halfa	Municipal supply and irrigation canal	1 Nr x 55 000	2 Nr x 18 800	Yes	Adequate
Zeidab	Nile	-	1 Nr x 16 000	Yes	Adequate considering production
Port Sudan	Municipal supply	1 Nr x 34 000	1 Nr x 34 000	Yes(2 Nr)	Adequate considering production
Kadugli	Shallow well	-	1 Nr x 15 000	No	Firefighting provisions are inadequate at all Nuba Mountains ginneries
Talodi	Nearby shallow well	-	-	No	
Kologi	By tanker from shallow well and reservoir (32 km)	1 Nr x 10 000	-	No	
Abu Gebeiha	Shallow well and part deep government well	1 Nr x 10 000	-	No	
Umm Berembeita	Shallow well by hand pump	1 Nr x 10 000	-	No	
Semeih	Reservoir (3 km) by pump	-	1 Nr x 4 500 (6 m high)	No	
Dilling	Municipal supply	1 Nr x 10 000	-	No	
Lagowa	Government deep well	1 Nr x 10 000	1 Nr x 11 000 (5 m high)	No	
Damazin	Municipal supply	2 Nr x 3 000	-	No	Insufficient storage

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TABLE 5.3

Proposed Improvements to Firefighting Water Supply Systems

Ginnery	Additional high level tank	Yard hydrant system required	Nr of hydrants	Estimated cost FE (US$ '000)	Estimated cost Total (LS '000)
Marangan	None	No	-	-	-
Hasaheisa	None	No	-	-	-
Bageir	None	No	-	-	-
Sennar	1 Nr 150 m^3	Yes	24	123	283
Hamadnallah	None	No	-	-	-
Kassab	1 Nr 150 m^3	Extend present system	19	102	234
Dueim	None	No	-	-	-
Kosti	1 Nr 100 m^3	Yes	24	108	249
Rabak	1 Nr 50 m^3	Extend present system	33	144	331
Fau	None	No	-	-	-
New Halfa	None	No	-	-	-
Zeidab	None	No	-	-	-
Port Sudan	None	No	-	-	-
Kadugli	1 Nr 100 m^3	Yes	12	69	158
Talodi	1 Nr 50 m^3	Yes	8	50	114
Kologi	1 Nr 50 m^3	Yes	8	50	114
Abu Gebeiha	1 Nr 50 m^3	Yes	8	50	114
Umm Berembeita	1 Nr 50 m^3	Yes	8	50	114
Semeih	1 Nr 150 m^3	Yes	12	77	176
Dilling	1 Nr 50 m^3	Yes	8	50	114
Lagowa	None	Yes	8	30	70
Damazin	1 Nr 50 m^3	No	-	18	40

Note : Although costs of improvements are shown for Nuba Mountains ginneries it is doubtful if the present production justifies the investment involved.

TABLE 5.4

Sudan Gezira Board
Costs of Firefighting Equipment

	Item	Unit FE cost (US $)	Number required	FE cost (US $)	Total cost (LS)
1.	Fire tender with 800 gallon tank	96 768	3	290 304	562 319
2.	Land Rover rescue vehicle	37 632	2	75 264	145 786
3.	High pressure fire pumps on trailers	12 544	8	100 352	194 382
4.	2½" dia. fire hose	171	300	51 408	99 577
5.	4" dia. suction hose	164	25	4 080	7 903
6.	4" dia. strainers	83	10	823	1 594
7.	Basket strainers	50	20	1 008	1 952
8.	Light alloy branch pipes	63	20	1 254	2 429
9.	Dividing and collecting breachings	81	20	1 613	3 124
10.	Suction wrenches	22	20	448	868
11.	Mechanical foam generators	631	10	6 306	12 215
12.	25 litre drums of foam making compound	57	100	5 712	11 064
13.	Hose repair machines	358	3	1 075	2 082
14.	Hose binding machines	1 792	3	5 376	10 413
15.	Protective clothing suits	63	30	1 882	3 645
16.	Fire helmets	197	100	19 712	38 182
17.	Light alloy hose ramps	358	10	3 584	6 942
18.	Fire extinguishers	90	300	26 880	52 067
19.	Hose reels	206	300	61 824	119 753
20.	High expansion foam machines	3 360	5	16 800	32 542
21.	25 litre cans of chemical foam compound	49	100	4 928	9 546
22.	Breathing apparatus sets	538	30	16 128	31 240

Water should comply with World Health Organisation Standards and any water taken from surface water sources requires treatment including filtration and chlorination.

5.3.2 Works Required

The present status of the water supply systems for domestic and other purposes at ginneries is summarised in Table 5.5. The improvements required are discussed below :

(a) Marangan, Hasaheisa and Bageir

All these ginneries report shortages but are relatively well supplied with water and have reasonable storage facilities. Based on the rated capacity (5 000 gallons/h) of the borehole pumps and 18 h/d pumping the following supplies are available :

	litres/day
Marangan	2 000 000
Hasaheisa	1 200 000
Bageir	800 000

These supplies should be sufficient for the factories and immediately associated areas. If further water is required it is suggested that, as a first measure, the firefighting wells not already connected to the domestic system are connected into the system. The works required for such connections would be minor.

As the main water demand must originate from outside the immediate ginning complex it would be appropriate for any increase in supplies to be provided as part of the general rural water supply programme. No investments to increase water supplies for these three ginneries are therefore included in the project.

(b) Sennar

A storage tank is required to provide a safeguard against cuts in the municipal supply. A nominal 50 m^3 tank is recommended.

(c) Kassab

It is recommended that a supply is provided from the Blue Nile. A pump station (5 l/s), 500 m long 100 mm diameter pipeline and small water treatment works (150 m^3/d) are required.

(d) Rabak

It is recommended that a small water treatment works (50 m^3/d) is constructed to treat the water pumped from the White Nile. An elevated storage tank (50 m^3) is also required.

TABLE 5.5

Present Status of Water Supply for Domestic Purposes

Ginnery	Source	Storage (gallons)	Comments
Marangan	5 deep wells	1 x 16 000 1 x 20 000	shortage reported
Hasaheisa	3 deep wells	16 000	shortage reported
Bageir	2 deep wells (one also used for fire water)	10 000	shortage reported
Sennar	municipal supply	-	supply is frequently cut
Hamadnallah	2 deep wells	30 000	no shortage reported
Kassab	tanker for potable + deep well (saline)	17 000	shortage of potable water
Dueim	municipal supply	-	no shortage reported
Kosti	municipal supply	-	shortage reported
Rabak	municipal supply + direct from White Nile	140 000 (shared with fire-fighting)	water from White Nile is not treated, municipal supply is frequently cut
Fau	municipal supply	-	no shortage reported
New Halfa	municipal supply	-	no shortage reported
Zeidab	2 deep wells (under construction)	2 x 5 500	no shortage reported
Port Sudan	municipal supply	-	pressure sometimes low
Kadugli	shallow well	15 000	shortage reported
Talodi	shallow well	1 500	no shortage reported
Kologi	shallow well and tanker	-	shortage reported
Abu Gebeiha	shallow well	1 000	no shortage reported
Umm Berembeita	shallow well, hand pump and tanker	-	shortage reported
Semeih	surface reservoir	4 500	water is untreated
Dilling	municipal supply	-	a shallow well on site could be used if pump available
Lagowa	deep well	11 000	no shortage reported
Damazin	municipal supply	-	no shortage reported

(e) Nuba Mountains

All the Nuba Mountains ginneries except Talodi, Abu Gebeiha and Lagowa suffer from water shortages, in some cases severe. The solutions to the water supply problems are not straightforward, require detailed study and need to be considered in relation to the water supply problems of the associated townships. A number of studies of the water supply problems in the area have been carried out, principally by PRC Engineering Consultants Inc., in 1980. The development of cotton production in the Nuba Mountains area will require improvements in water supplies not only for ginnery purposes but also for general purposes such as staff housing, workshops, farmers and farm labour. It is considered that the general improvement of water supplies is outside the scope of the Cotton Marketing Project but it should form one element of an integrated development programme for the Nuba Mountains.

The costs of the improvements outlined above are estimated to be as follows :

Ginnery	FE cost (US$)	Total cost (LS)
Sennar	18 000	39 560
Kassab	92 000	206 920
Rabak	90 000	203 556

5.4 Hardstandings

Reference has been made in Chapter 2 to the use of hardstandings for short term storage of bales of lint and bags of cottonseed. The hardstandings provide formalised stacking areas to assist with mechanical handling and in relieving congestion in the ginnery yards. They also provide raised areas where stacked lint and seed can be protected against damage due to rain and standing water. It is considered that there should be sufficient hardstandings to provide storage for about 2 weeks production of lint and cottonseed.

It is proposed that a standard 30 m x 20 m unit be adopted for hardstandings, as at present provided at Bageir. It is possible to stack on each such unit, allowing for access ways for mechanical handling, some 1 800 bales of lint or 5 000 bags of cottonseed (see Figure 5.1). It is suggested that each major ginning factory should have at least 8 Nr 30 m x 20 m units or the equivalent to handle typical production as shown in Table 5.6.

Where additional hardstandings are required it is proposed that they consist of a raised area of compacted sand/gravel contained by a low brick wall on three sides and a concrete access ramp on one side (see Figure 5.2). The alternative of providing a surfaced (paved) hardstanding was examined (see Figure 5.3). The cheapest type of surfacing is a bitumen surface dressing and this would almost double the cost of the hardstanding. It is considered that this extra cost would not be justified.

TABLE 5.6

Calculation of Storage Provided by Hardstandings

	Typical major roller gin factory	Typical major saw gin factory
Cotton variety	Long staple	Medium staple
Typical capacity (tonnes seed cotton/week)	1 500	1 200
Lint out-turn (%)	34	38
Seed out-turn (%)	61	57
Weight of bale (kg)	188	188
Weight of bag (kg)	90	50
Lint production (bales/week)	2 700	2 400
Cottonseed production (bags/week)	10 000	13 700
Nr of 20 m x 30 m units for 1 week's production	3.5	4.1
Nr of weeks storage provided by 8 Nr 20 m x 30 m units	2.3	2.0

The existing hardstandings at ginneries are listed in Table 5.7 together with required additions to meet the criterion given above and the estimated costs.

The use of stillage on the hardstandings is recommended to ensure full protection of lint from ground damp and possible staining. For the SGB ginneries, the supply of stillage is envisaged under GRP. There is also a requirement for additional stillage for the Rahad ginneries, and it is proposed that this should be supplied through the Cotton Marketing Project, at an estimated cost of LS 216 000 (for 5 factories).

The hardstandings should be located as close as possible to the ginning factory and the rail and/or road access to minimise haul distances. A typical layout for a Gezira factory is shown in Figure 5.4. Actual circumstances vary at each end of each factory, particularly as regards the location of GLR lines, and the layout of hardstandings would have to be planned individually for each case. The layout for a Rahad factory is shown in Figure 5.5.

5.5 Roads

5.5.1 Present Situation

At many ginneries, there is at present little or nothing in the way of formal access roads, and movement of vehicles in ginnery yards is often difficult. The layouts of most of the older ginneries were originally planned to facilitate the use of Sudan Railways for the removal of lint and cottonseed and, at the SGB

Figure 5.1

Compacted Sand and Gravel Hardstanding

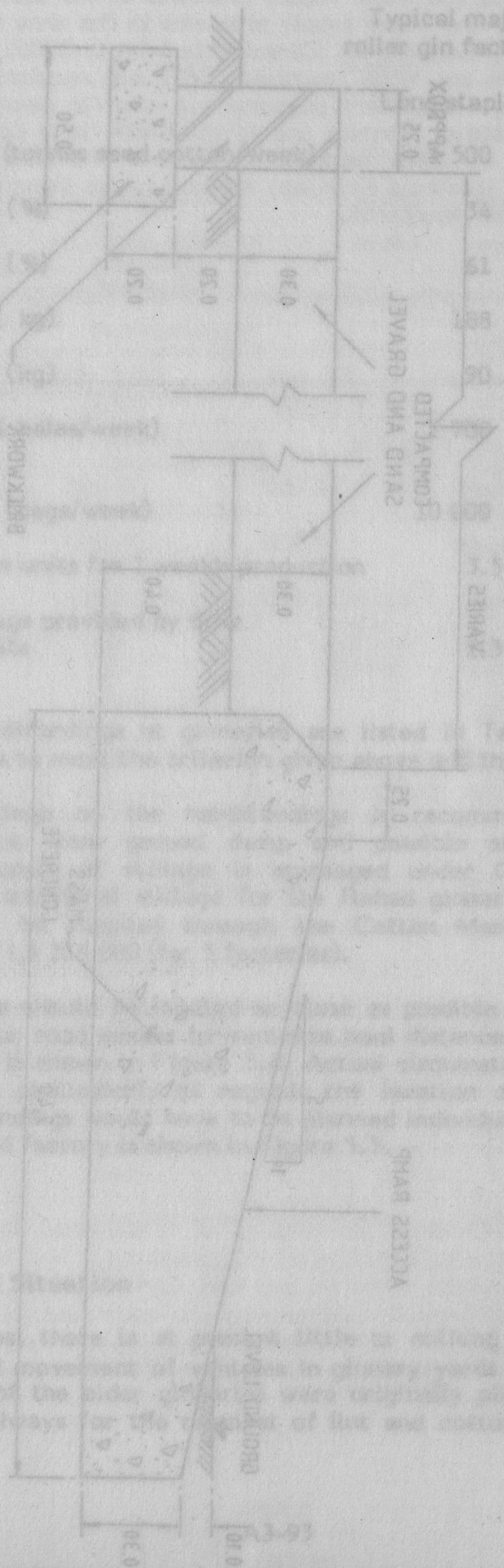

REINFORCED CONCRETE
GUTTER
GRID
GRID
GRID

Figure 5.2

Detail of Double Sand Seal Hardstanding

STEEL ROOFING
REINFORCED CONCRETE
CONCRETE
MASS
SAND FILLED

Figure 5.3

Sketch Plan of Hardstanding for Bale Storage

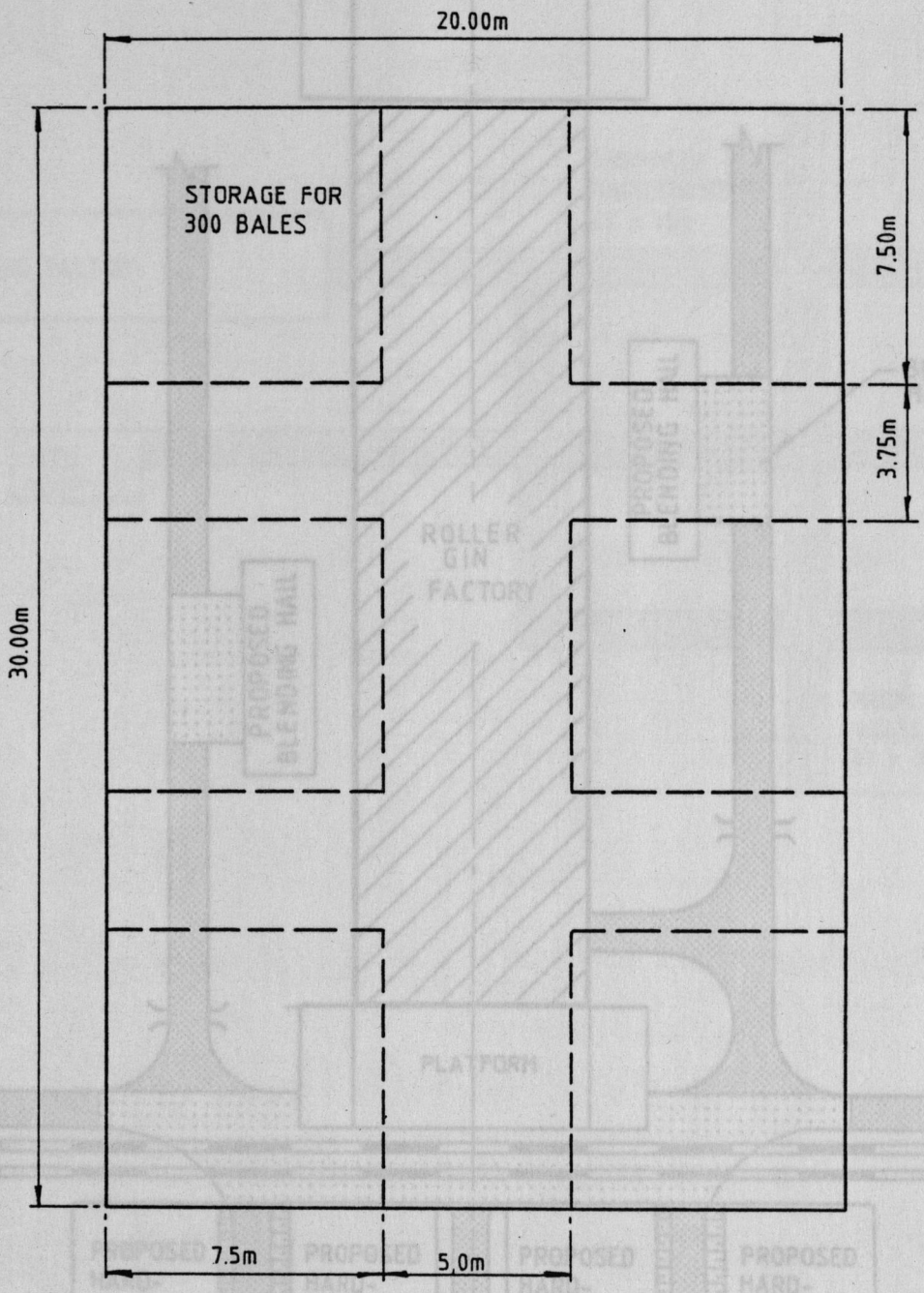


Figure 5.3

Sketch Plan of Hardstanding for Bale Storage

Figure 5.4

Plan of Roads and Hardstandings Adjacent to Ginnery

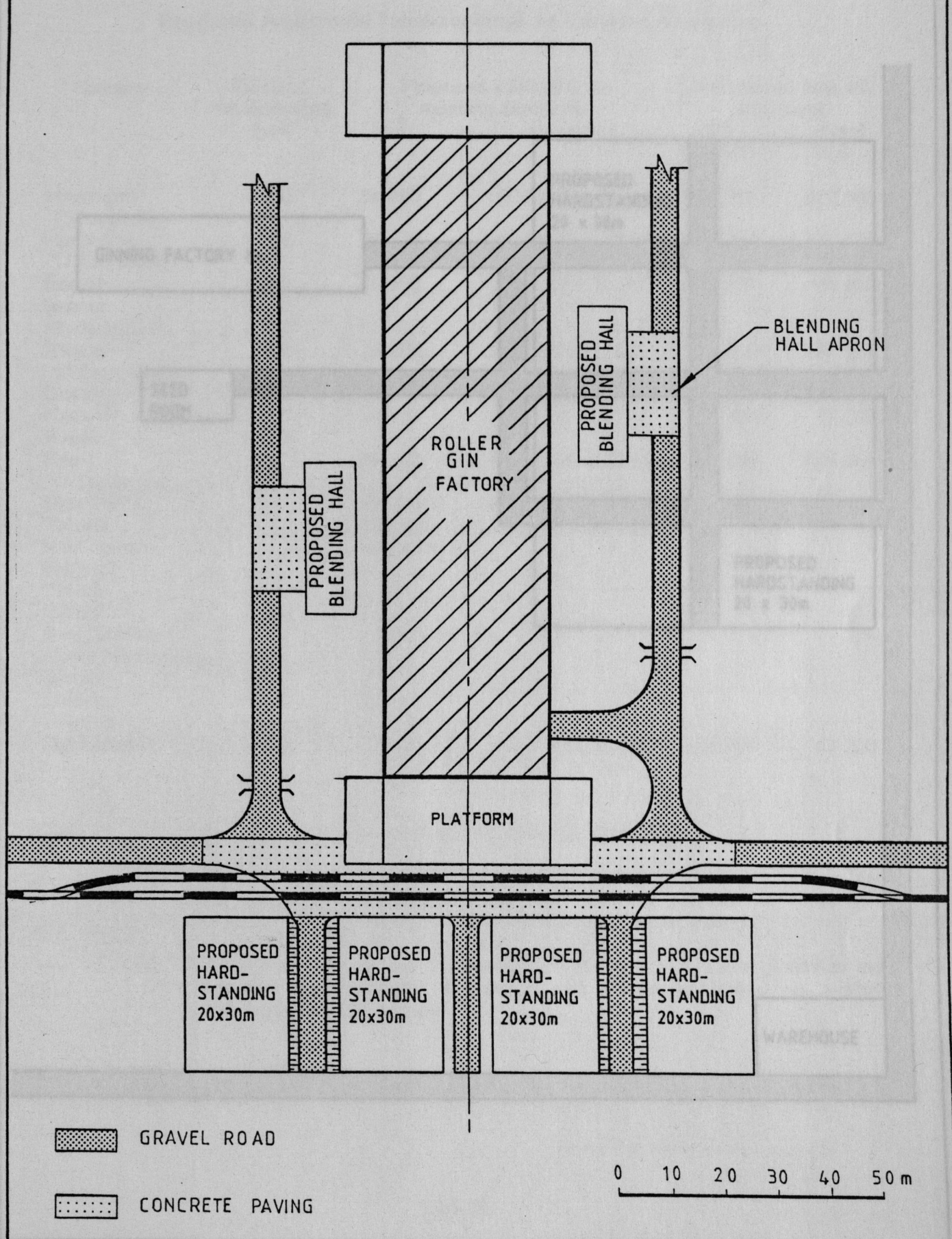


Figure 5.4

Plan of Roads and Hardstandings Adjacent to Ginnery

Figure 5.5

Schematic Layout of Roads at Fau Ginning Factory

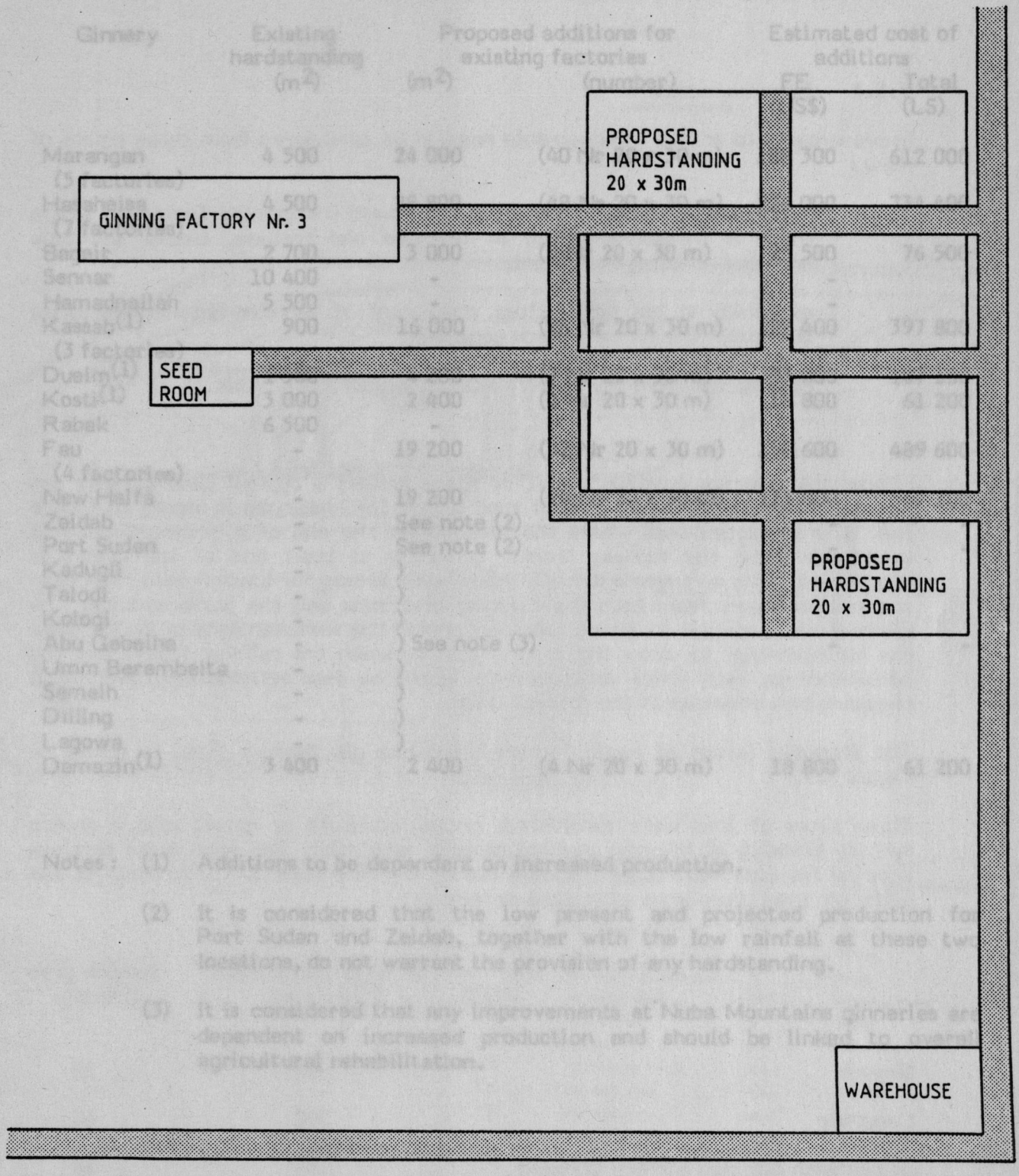


Figure 5.5

Schematic Layout of Roads at Fau Ginning Factory

TABLE 5.7

Proposed Additional Hardstandings at Existing Ginneries

Ginnery	Existing hardstanding (m^2)	Proposed additions for existing factories (m^2)	(number)	Estimated cost of additions FE (US$)	Total (LS)
Marangan (5 factories)	4 500	24 000	(40 Nr 20 x 30 m)	188 300	612 000
Hasaheisa (7 factories)	4 500	28 800	(48 Nr 20 x 30 m)	226 000	734 400
Bageir	2 700	3 000	(5 Nr 20 x 30 m)	23 500	76 500
Sennar	10 400	-		-	-
Hamadnallah	5 500	-		-	-
Kassab(1) (3 factories)	900	16 000	(26 Nr 20 x 30 m)	122 400	397 800
Dueim(1)	1 500	4 200	(7 Nr 20 x 30 m)	33 000	107 100
Kosti(1)	3 000	2 400	(4 Nr 20 x 30 m)	18 800	61 200
Rabak	6 500	-			
Fau (4 factories)	-	19 200	(32 Nr 20 x 30 m)	150 600	489 600
New Halfa	-	19 200	(24 Nr 20 x 30 m)	113 000	367 200
Zeidab	-	See note (2)		-	-
Port Sudan	-	See note (2)		-	-
Kadugli	-	)			
Talodi	-	)			
Kologi	-	)			
Abu Gebeiha	-	) See note (3)		-	-
Umm Berembeita	-	)			
Semeih	-	)			
Dilling	-	)			
Lagowa	-	)			
Damazin(1)	3 400	2 400	(4 Nr 20 x 30 m)	18 800	61 200

Notes: (1) Additions to be dependent on increased production.

(2) It is considered that the low present and projected production for Port Sudan and Zeidab, together with the low rainfall at these two locations, do not warrant the provision of any hardstanding.

(3) It is considered that any improvements at Nuba Mountains ginneries are dependent on increased production and should be linked to overall agricultural rehabilitation.

ginneries, the Gezira Light Railway (GLR) for delivery of seed cotton. The railway lines interfere with the movement of road vehicles which are increasingly being used, and in the absence of proper crossings there is considerable damage to the railway tracks and unnecessary wear and tear on the vehicles. At Marangan and Hasaheisa, vehicles travelling along the length of the ginnery sites usually run just inside the railway lines (see Figure 5.4) and are obliged to go over the bale loading platforms in order to get past the ginning factories; this is causing damage to the platforms.

5.5.2 Improvements

Improvements to access arrangements need to be considered from three points of view :

- movement of vehicles immediately around the ginning factories, where there is intensive traffic of tractors and trailers, trucks and bale and seed handling equipment;
- especially at the larger sites, movement of vehicles between factories and within the ginnery yards generally;
- road access from the ginnery sites to nearby main roads.

Figure 5.4 shows a possible layout of roads around a typical Gezira roller gin factory, while the proposed overall road layout for Marangan is shown on Figure 5.6. It is envisaged that where the road passes the end of a ginning factory it would run along the railway tracks; generally at least one of the tracks is unoccupied. This arrangement would allow easy access for loading onto both road and rail transport from both the existing platforms and the hardstandings. The alternatives would be to divert the road behind the hardstandings or to set back the hardstandings to allow the road to run between the railway tracks and the hardstandings; both these arrangements would be less satisfactory, while still requiring two crossings of the railway lines.

The proposed layout of roads for a typical saw gin factory (Fau) is shown on Figure 5.5.

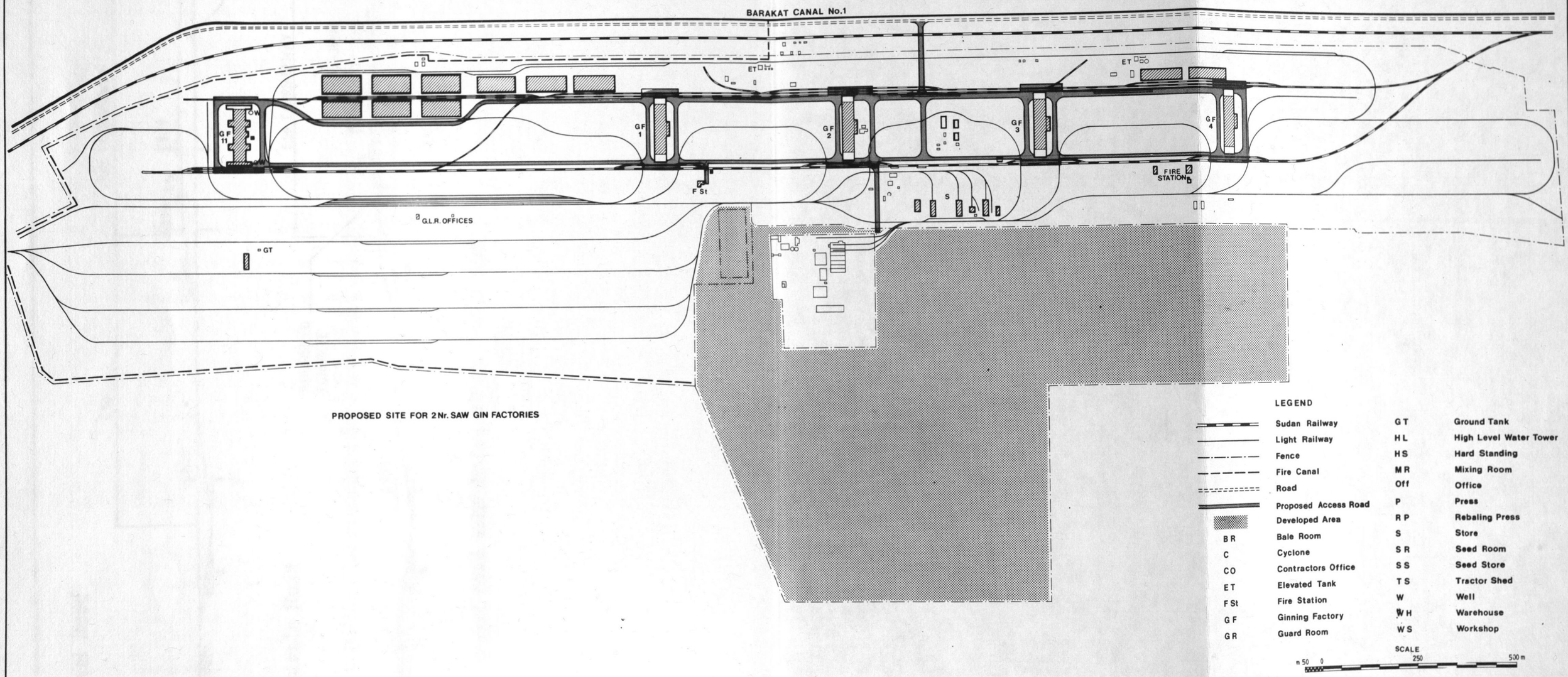
Three types of road were considered: gravel, concrete or gravel with a double surface dressing of bitumen coating blinded with sand. The road cross sections adopted for cost estimating purposes are shown on Figure 5.7. The costs of the different road types were estimated as follows :

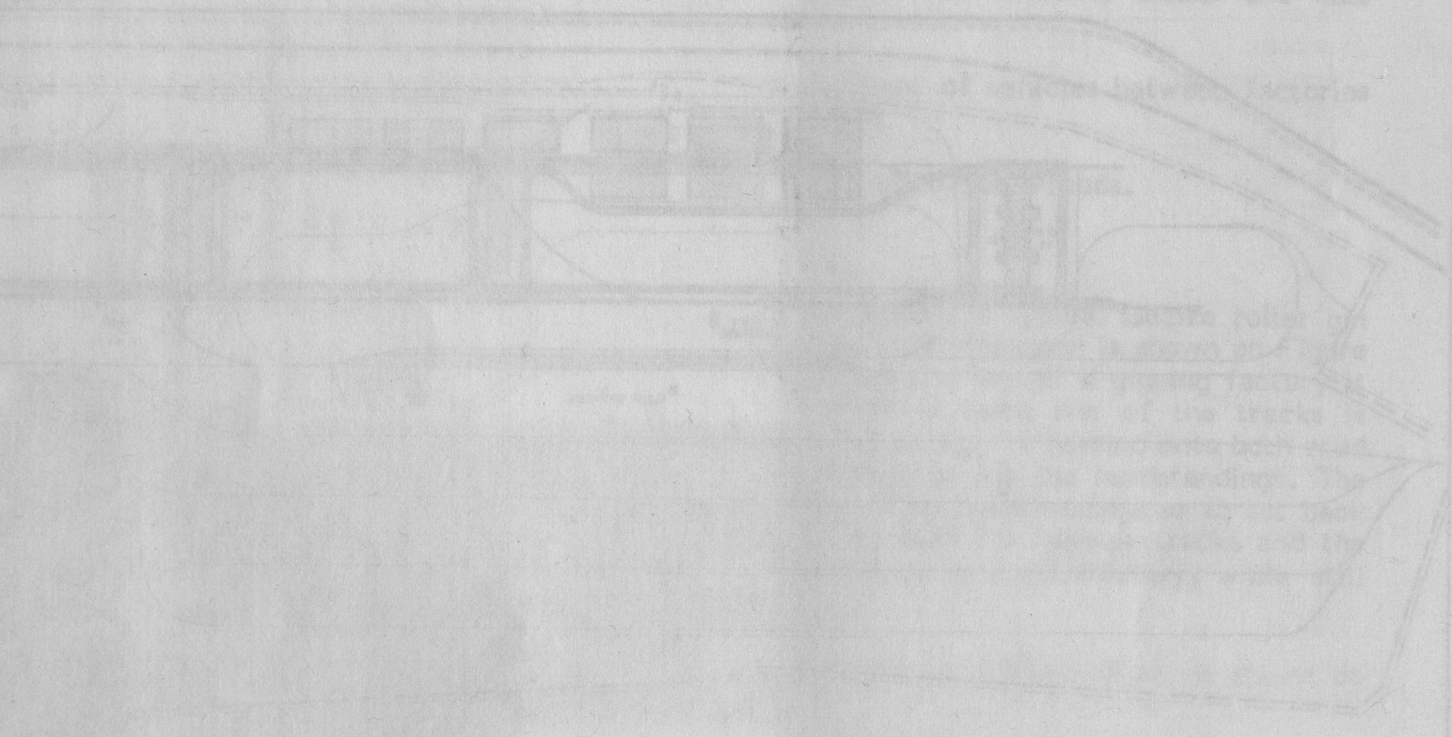
	5 m wide access road (LS/m run)	Service area (LS/m^2)
Gravel	45	10
Concrete	300	60
Gravel with bitumen surface dressing	145	30

Figure 5.6

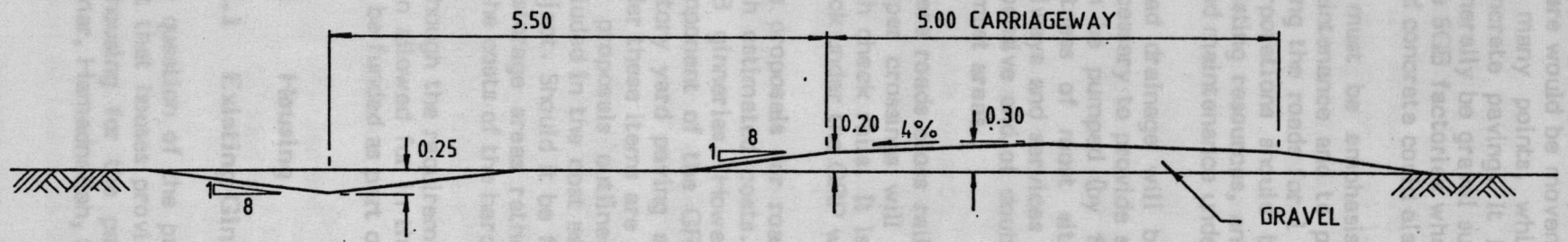
Proposed Layout of Access Roads

Marangan Ginnery

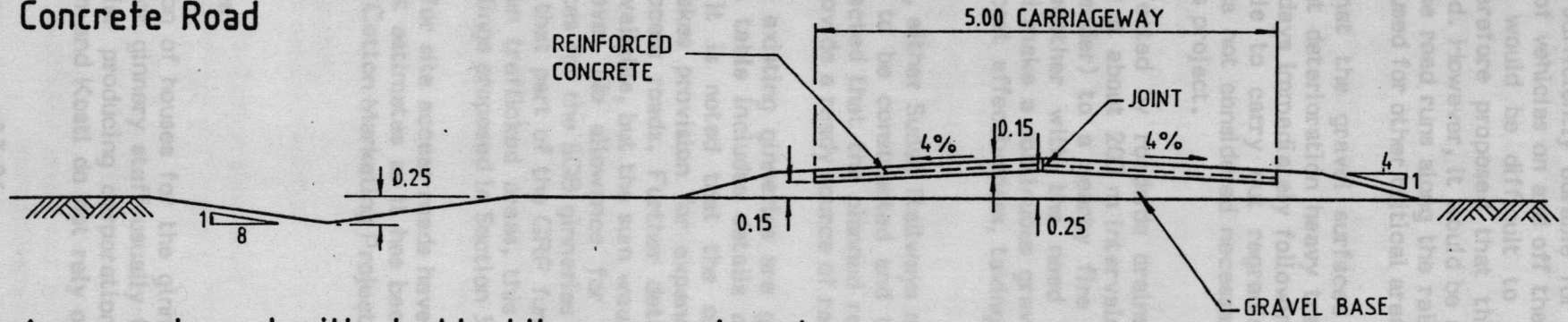




1. Gravel Road



2. Concrete Road



3. As gravel road with double bitumen sand seal.

Typical Road Details

Figure 5.7

Figure 5.7

Typical Road Details

Taking account of the above relative costs it is proposed that ginnery access roads should be gravel surfaced. In the service areas immediately adjacent to ginning factories, loading platforms and hardstandings a sealed surface is desirable because of the more frequent movement of tractors, trailers, trucks and bale and seed handling equipment in these areas. However, a bitumen surface dressing is unlikely to be sufficiently durable for these areas, particularly as there would be movement of vehicles on and off the edges of the surfaced areas at many points, while it would be difficult to justify the expense of full concrete paving. It is therefore proposed that the service areas should also generally be gravel surfaced. However, it would be necessary to use concrete at the SGB factories where the road runs along the railway tracks (see Figure 5.4), and concrete could also be used for other critical areas.

It must be emphasised that the gravel surfaced roads will require regular maintenance and to prevent deterioration heavy traffic should be stopped from using the roads for 1 or 2 days immediately following heavy rain. The producing corporations should be able to carry out regrading of the roads with their existing resources, and it is not considered necessary to provide equipment for road maintenance under this project.

Road drainage will be effected by roadside drains. At most sites it will be necessary to provide sumps at about 200 m intervals from which drainage water can be pumped (by fire tender) to a nearby fire canal or disposal site. The flatness of most sites together with the need for drains to cross roads, railways and services would make a continuous gravity drainage disposal system expensive and of doubtful cost effectiveness, taking account of the low rainfall in most areas.

Where roads cross railways, either Sudan Railways or the Gezira Light Railway, proper crossings will need to be constructed and the existing tracks provided with check rails. It is expected that the planned relaying of parts of the GLR track under the GRP will provide a ready source of rails for this purpose.

The proposals for roads at existing ginneries are given in Table 5.8, together with estimated costs. This table includes details of the requirements for the SGB ginneries. However, it is noted that the cotton handling and storage component of the GRP makes provision for expenditure of LS 1.6 million on factory yard paving and access roads. Further details of the works envisaged under these items are not available, but the sum would be adequate to implement the proposals outlined above. No allowance for roads has, therefore, been included in the cost estimates for the SGB ginneries under the Cotton Marketing Project. Should it be found that part of the GRP funds are to be used for paving of storage areas rather than trafficked areas, this would be offset by savings in the costs of the hardstandings proposed in Section 5.4.

Although the requirements for site access roads have been shown, these have not been allowed for in the cost estimates as it has been indicated that they would not be funded as part of the Cotton Marketing Project.

5.6 Housing

5.6.1 Existing Ginneries

The question of the provision of houses for the ginneries is complicated by the fact that houses provided for ginnery staff usually form part of a general pool of housing for the particular producing corporation. The private ginneries at Sennar, Hamadnallah, Dueim and Kosti do not rely on the producing corporation

TABLE 5.8

Requirements for Additional Roads at Existing Ginneries

Ginnery	Site access road (m)	Internal access roads (m)	Factory service areas (m^2)	Estimated cost FE (US$)	Estimated cost Total (LS)	Comments
Marangan	-	4 800	20 000	243 400	791 000	service areas include 7 500 m^2 concrete paving
Hasaheisa	(2 000)(2)	3 950	20 000	231 600	752 750	service areas include 7 500 m^2 concrete paving
Bageir	(2 000)(2)	350	4 000	40 200	130 750	service areas include 1 500 m^2 concrete paving
Sennar(1)	-	-	1 750	5 400	17 500	single factory, no access roads required
Hamadnallah(1)	-	-	3 500	10 800	35 000	single factory no access roads required
Kassab(1)	-	-	5 000	15 400	50 000	compact site, no access roads required
Dueim(1)	-	-	3 500	10 800	35 000	single factory, no access roads required
Kosti(1)	-	-	1 500	4 600	15 000	single factory, no access roads required
Rabak(1)	-	-	4 000	12 300	40 000	single factory, no access roads required
Fau	-	2 100	11 600	64 800	210 500	existing gravel roads need improvement
New Halfa	-	-	8 700	28 000	91 000	existing gravel roads are adequate; 3 Nr culverts required (LS 4 000)
Zeidab	-	-	-	-	-	see note (3)
Port Sudan	-	-	-	-	-	see note (3)
Nuba Mountains	-	-	-	-	-	see note (4)
Damazin(1)	(700)(5)	-	2 500	7 700	25 000	

Notes: (1) Additions to be dependent on increased production.
(2) Connection to main road required but not included in cost estimate.
(3) No roads required in view of low production and low rainfall.
(4) Any improvements at the Nuba Mountains ginneries should be linked to overall agricultural rehabilitation.
(5) Road to railway station required but not included in cost estimate.

for housing. The houses provided at each ginnery site are listed in Annex 1 - Inventory. Although most ginneries report housing shortages, they are adjacent to population centres and private housing is available to meet supplementary requirements. The provision of any further houses must be considered together with overall housing requirements of the relevant corporation and the rehabilitation programmes being undertaken for several of the major schemes.

The only area where the shortage of housing for ginnery staff is critical is in the Nuba Mountains where the isolated locations of the ginneries and the inadequate housing make it difficult to recruit and retain key ginnery staff. It is therefore proposed that, under the project, houses should be constructed to enable all senior and middle grade staff to be housed. The existing provision of houses in the area is given in Annex 1 - Inventory, and the additional houses proposed, together with cost estimates, are summarised in Table 5.9.

TABLE 5.9

Nuba Mountains Corporation
Requirements for Additional Houses for Ginnery Staff

Ginnery	Additional houses required	Unit cost (LS '000)	FE cost (US$ '000)	Total cost (LS '000)
Kadugli	1 Nr senior staff house	60	18	60
	3 Nr middle staff houses	35	32	105
Talodi	1 Nr middle staff house	35	11	35
Kologi	1 Nr middle staff house	35	11	35
Abu Gebeiha	2 Nr middle staff houses	35	22	70
Umm Berembeita	1 Nr middle staff house	35	11	35
Semeih	1 Nr middle staff house	35	11	35
Dilling	-	-	-	-
Lagowa	-	-	-	-

5.6.2 New Ginneries

For the new saw ginning factories which are proposed (see Chapter 4) additional housing would be required. In all cases the new factories would be attached to existing ginneries. The senior management, engineers, technicians, graders, etc. of the existing ginnery would also cover the new factory.

It is assumed that the following additional staff would be required for each new factory:

	Nr
Shift engineer	2
Assistant cotton classifier	2
Clerks	2
Assistant production supervisor	1
Gin operators	8
Press operators	2
Fitter mechanics	2
Assistant yard supervisor	1
Firemen	3
Permanent labourer	8

The houses required for the additional staff are :

	Nr	Unit cost (LS '000)	FE cost (US$ '000)	Total cost (LS '000)
Middle staff house	6	35	65	210
Junior staff house	25	25	192	625

5.7 Fences

Ginnery boundary fences are generally some 2 m high formed by 10 strands of barbed or plain wire with steel angle posts at about 4 m intervals. The fences provide little security but serve to demarcate the site and to prevent livestock from entering. There are reported to be no serious security problems at the ginneries, with only minor pilfering taking place. In view of the large numbers of workers required at the ginneries some pilfering is to be expected and it is considered that upgrading of the boundary fence to provide increased security is not warranted.

At some sites the fencing is incomplete, in need of repair or replacement and works are required to bring the fencing up to standard. The sites where fencing works are required together with the estimated costs are given in Table 5.10.

5.8 Sewage Disposal

The provisions for sanitation and sewage disposal vary considerably from site to site. The sanitation provided for ginnery workers is by means of either pit latrines, bucket latrines or aqua privies (see Annex 1, Inventory, for details at particular ginneries). The facilities provided for offices and houses are similar except that in a few cases full water-borne disposal systems with septic tanks are provided.

In most areas there is a general programme for the replacement of pit and bucket latrines by aqua privies and water-borne disposal systems. The progress of such programmes is constrained by availability of finance and the prior requirement for the provision of adequate water supplies.

Although it is clearly desirable that sanitation facilities be improved at ginneries the present facilities are generally adequate and do not cause any constraint on ginnery operation. In these circumstances it is not considered appropriate that any upgrading of facilities be included as an element of the present Cotton Marketing Project. It is anticipated that in time all bucket and pit latrines will be replaced by aqua privies or water-borne sewage disposal systems under the general sanitation improvement programmes.

5.9 Surface Drainage

There are generally no special provisions for surface drainage at ginnery sites. This reflects the fact that the ginning season is planned so that ginning is finished before the onset of the rains. It also reflects the fact that, in

TABLE 5.10

Fencing Works at Ginneries

Ginnery	Present condition	Replacement length required (m)	FE cost (US$)	Total cost (LS)
Marangan	Good	Nil		-
Hasaheisa	Good	Nil		-
Bageir	Good	Nil		-
Sennar	Poor, requires replacement	1 750	7 300	23 600
Hamadnallah	Good	Nil		-
Kassab	Good	Nil		-
Dueim	Good	Nil		-
Kosti	Good	Nil		-
Rabak	Good	Nil		-
Fau	Good	Nil		-
New Halfa	Good	Nil		-
Zeidab	Good	Nil		-
Port Sudan	Poor, requires replacement	1 170	4 900	15 800
Kadugli Talodi Kologi Abu Gebeiha Umm Berembeita Semeih Dilling Lagowa	See note (1)	Nil		-
Damazin	Good	Nil		-

Note : (1) It is considered that replacement of fences at the Nuba Mountains ginneries is not warranted at the present time.

general, flooding during the rains is not a problem and adequate natural drainage takes place. The ginneries where some surface drainage problems are reported are :

Marangan	Hasaheisa
Bageir	Kassab
Fau	New Halfa
Kadugli	Lagowa
Damazin	

The problems at Marangan, Hasaheisa, Bageir and Fau are localised and drainage can be achieved by digging sumps and using fire pumps to pump ponded water to the fire canal or to a disposal site. At Kassab and New Halfa existing problems can be ameliorated by cleaning out existing drains. At Kadugli, Lagowa and Damazin some bunding of the site may be justified. The works required where problems are reported would be minor and could be undertaken by the relevant producing corporation using available resources. The fact that such works have not been undertaken indicates that the problem cannot be severe. It is therefore considered that no surface drainage works should be included as part of the Cotton Marketing Project.

CHAPTER 6

POWER SUPPLIES

6.1 General

Electrical power is used at 14 of the 22 ginneries, either supplied by the National Electricity Corporation (NEC) or privately produced by diesel alternators, or both. Details of the power source at each ginnery are given in Table 6.1. The remaining 8 ginneries are driven by diesel engines and lineshafts.

6.2 NEC Power Supply

6.2.1 Present Situation

In the middle of 1982 the Public Electricity and Water Corporation (PEWC) was re-organised, the functions of electricity supply and water supply being separated. Under the new arrangements the NEC is responsible for the supply and distribution of electricity in the Blue Nile Grid area and for systems in other regions where the maximum system voltage exceeds 33 kV. Where the voltage is 33 kV or less generation and distribution of electricity is the responsibility of the Regional Government.

The general layout of the Blue Nile Grid and the Eastern Grid is shown in Figure 6.1.

The Blue Nile Grid is the largest electricity system in Sudan and transmits electrical power from the hydro-electric power stations at Roseires and Sennar on the Blue Nile over a 220 kV transmission line to Khartoum. Power from the 220 kV grid is fed into the 110 kV system at Sennar junction, Wad Medani and Kilo X for further transmission at 110 kV and 33 kV before being distributed to consumers at lower voltages. Electrical load is also fed at 110 kV as far west as Kosti and as far east as Fau.

The Eastern Grid comprises a hydro-electric power station with some supplementary diesel power generation at Khasm el Girba and a 66 kV transmission line to interconnect load centres including New Halfa.

Regional electrical supplies comprise mainly small installations with diesel engine plant of low output. Port Sudan is the largest load centre outside the Blue Nile Grid with a large proportion of industrial generation.

6.2.2 Future Plans

The Power III Project was launched by PEWC (now NEC) in 1980 and is being implemented by an autonomous task force set up within NEC and by consultants. This project, which is due for completion by mid 1984, mainly involves improving the Blue Nile Grid by providing additional hydro and thermal power generation capacity and reinforcing the transmission system.

The Power IV Project plans for the development of further generation and transmission facilities to the horizon of approximately 1988/89; the final report submission to the World Bank was scheduled for June 1983. This project is intended to cover four main areas of development:

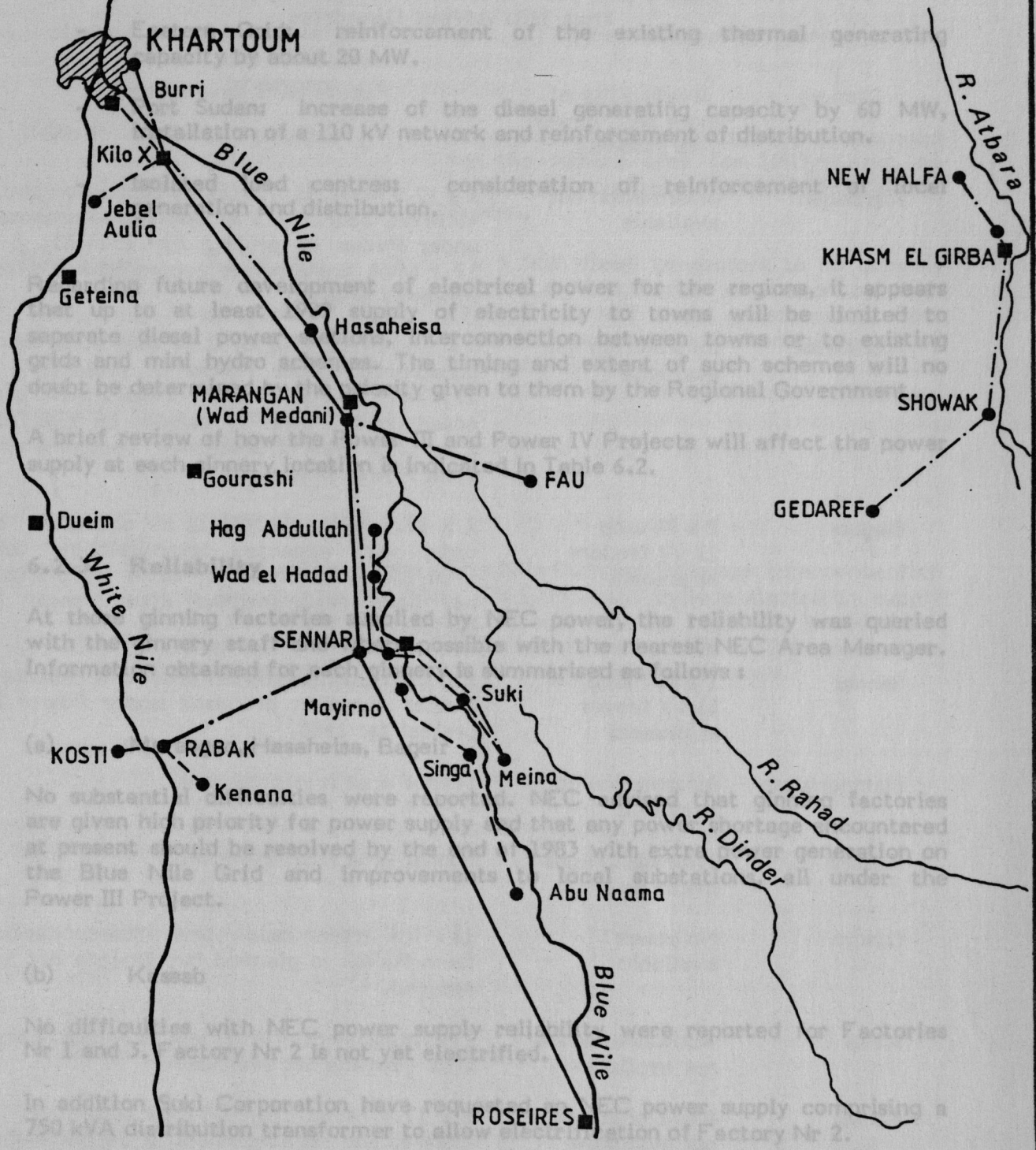
TABLE 6.1

Existing Electrical Power Supply at Ginneries

Ginnery	Present electrical power supply	Nearest NEC source of power
Marangan	NEC	Blue Nile Grid
Hasaheisa	NEC	Blue Nile Grid
Bageir	NEC	Blue Nile Grid
Dueim	Private	Blue Nile Grid
Rabak	NEC and private	Blue Nile Grid
Kosti	NEC and private	Blue Nile Grid
Kassab	NEC (part)	Blue Nile Grid
Sennar	NEC (part)	Blue Nile Grid
Hamadnallah	Private	Blue Nile Grid
Fau	NEC	Blue Nile Grid
New Halfa	NEC and private	Eastern Grid
Zeidab	Private	Local generation (Atbara)
Port Sudan	NEC	Red Sea Grid (Port Sudan)
Kadugli	None	Local generation (Kadugli)
Kologi	None	None
Lagowa	None	None
Abu Gebeiha	None	None
Umm Berembeita	None	None
Talodi	None	None
Dilling	None	None
Semeih	None	None
Damazin	NEC	Blue Nile Grid

Figure 6.1

General Layout of Blue Nile Grid and Eastern Grid



LEGEND

- 220kv Transmission Line
- 110kv Transmission Line
- 66kv Transmission Line
- 33kv Transmission Line
- Power Station
- Isolated Substation

SCALE

km 0 20 40 60 80 100 km

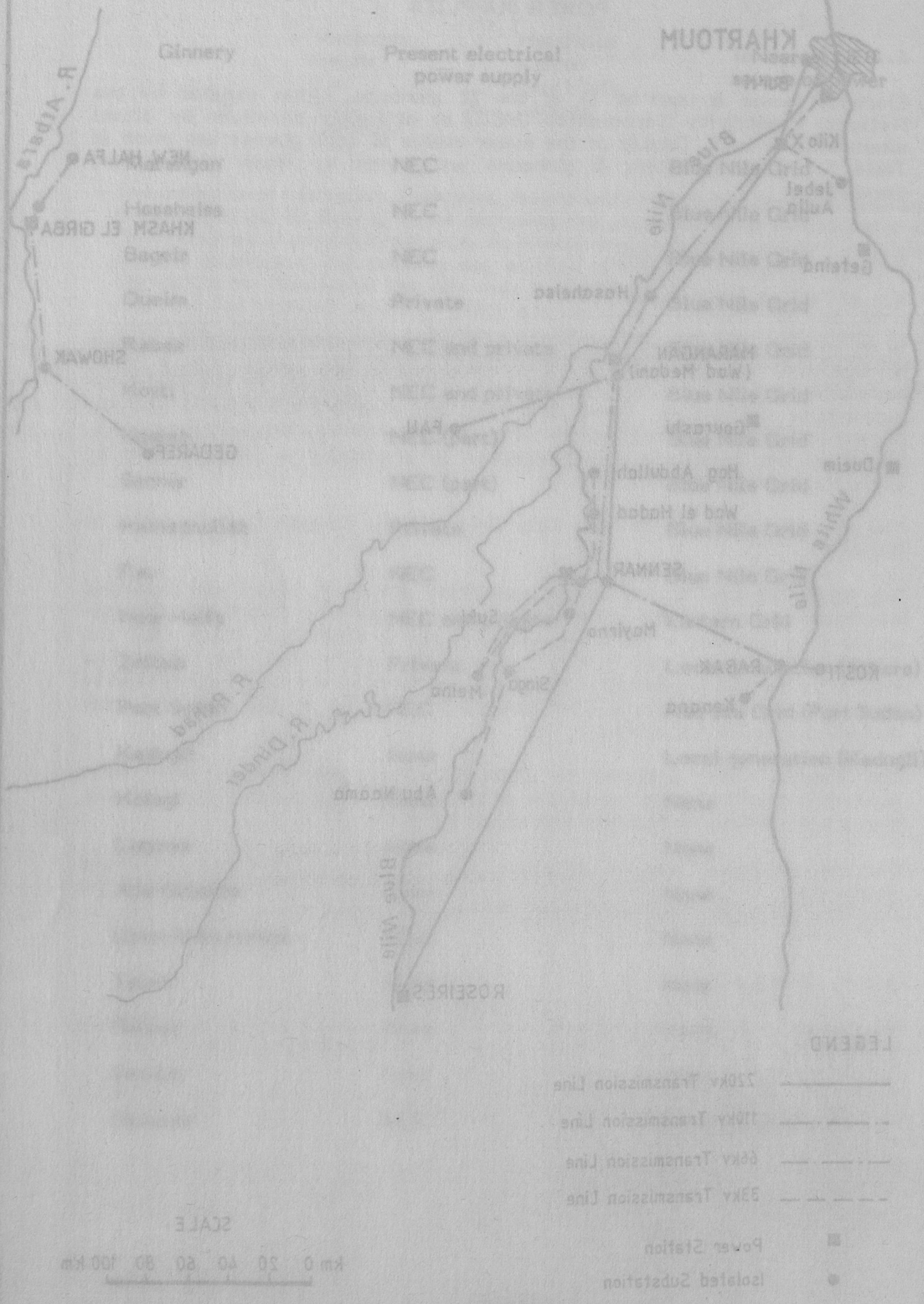
Figure 6.1

General Layout of Blue Nile Grid and Eastern Grid

TABLE 6.1

Existing Electrical Power Supply at Ginneries

Ginnery	Present electrical power supply
Margan	NEC
Hasaheisa	NEC
Bageir	NEC
Queim	Private
Rabak	NEC and private
Kosti	NEC and private
Kenana	NEC (part)
Sennar	NEC (part)
Fau	NEC
Sukki	NEC
Meina	Private
Singa	NEC
Abu Naama	NEC
Roseires	NEC



- Blue Nile Grid: reinforcement of existing hydro and thermal generation with the installation of about 270 MW of new generating plant together with some transmission reinforcement.

- Eastern Grid: reinforcement of the existing thermal generating capacity by about 20 MW.

- Port Sudan: increase of the diesel generating capacity by 60 MW, installation of a 110 kV network and reinforcement of distribution.

- Isolated load centres: consideration of reinforcement of local generation and distribution.

Regarding future development of electrical power for the regions, it appears that up to at least 1989 supply of electricity to towns will be limited to separate diesel power stations, interconnection between towns or to existing grids and mini hydro schemes. The timing and extent of such schemes will no doubt be determined by the priority given to them by the Regional Government.

A brief review of how the Power III and Power IV Projects will affect the power supply at each ginnery location is indicated in Table 6.2.

6.2.3 Reliability

At those ginning factories supplied by NEC power, the reliability was queried with the ginnery staff and where possible with the nearest NEC Area Manager. Information obtained for each ginnery is summarised as follows :

(a) Marangan, Hasaheisa, Bageir

No substantial difficulties were reported. NEC advised that ginning factories are given high priority for power supply and that any power shortage encountered at present should be resolved by the end of 1983 with extra power generation on the Blue Nile Grid and improvements to local substations, all under the Power III Project.

(b) Kassab

No difficulties with NEC power supply reliability were reported for Factories Nr 1 and 3. Factory Nr 2 is not yet electrified.

In addition Suki Corporation have requested an NEC power supply comprising a 750 kVA distribution transformer to allow electrification of Factory Nr 2.

(c) Sennar

No reported difficulty with NEC power supply reliability. Only part of the factory is electrified, the remainder being driven by a diesel engine and lineshafts.

TABLE 6.2

NEC Plans for Future Power Developments That Will Affect Ginneries

Ginnery	Availability of more NEC power at present	Future NEC developments
Marangan	Information not available	2 x 17.5 MVA, 110/33/11 kV substation and a 40 MVA, 220/110/11 kV substation proposed under Power IV project for 1984/85. 1 x 17.5 MVA transformer recommended after Power IV project.
Hasaheisa	Information not available	1 x 17.5 MVA, 110/33/11 kV substation being constructed under Power III project. 1 x 17.5 MVA + 1 x 7.5 MVA transformers proposed under Power IV project by 1984/85. 1 x 17.5 MVA transformer recommended after Power IV project.
Bageir	2 x 94 amp 11 kV feeders at present	2 x 17.5 MVA, 110/33/11 kV substation on order with expected commissioning date 1984/85. Additional 17.5 MVA transformer has been recommended after Power IV project.
Sennar	1 x 107 amp 11 kV feeder at present	220 kV transmission reinforcement Roseires/ Sennar Junction proposed under Power IV project for 1985.
Hamadnallah	Information not available	Sennar area reinforcement.
Kassab	Information not available	Sennar area reinforcement.
Dueim	No power available	110 kV transmission line interconnection from Rabak is planned but finance not yet secured.(1)
Kosti	Additional power not available	Transmission reinforcement at Sennar/Rabak area - details not available.
Rabak	Additional power not available	2 x 17.5 MVA, 110/33/11 kV substation for 1984/85 and reinforcement of Sennar/Rabak 110 kV line under Power IV project.
Fau	Not possible	1 x 12.5 MVA additional transformer recommended under Power IV project.
New Halfa	2 x 107 amp 11 kV feeders at present	Rehabilitation of Khasm el Girba power station proposed under Power IV project.

TABLE 6.2 (cont.)

Ginnery	Availability of more NEC power at present	Future NEC developments
Zeidab	Not possible	An extra 11 MW approximately is proposed for the Atbara area for 1985/86 but no programme available for electrification of Zeidab.
Port Sudan	1 x 96 amp 11 kV feeder at present	3 x 5 MW diesel generators to be commissioned at Port Sudan 'A' station by June 1983. 3 x 5 MW diesel generators at Port Sudan 'C' station to be commissioned by November 1983.
Damazin	Information not available	-

Notes : (1) Electrification of the White Nile Pumping Schemes: Interconnection of Dueim with the Blue Nile Grid would include electricity supply for the White Nile irrigation schemes. By 1985 this would cover Dueim and Um Gar pumping schemes and by 1986 to 1990 would cover Mashkur, Mallaha and Goz en Nagra pumping schemes.

Source : NEC.

(d) Kosti

NEC provided a power feed to the ginning factory on 1 March 1983, but the supply is not proving to be reliable with power cuts of between 1 and 6 hours duration. The NEC Area Manager advised that the reason for power failures was the present

11 kV overhead line being fully loaded at peak hours (in the evening) and advised that a 33 kV line between Rabak and Kosti was well advanced and should resolve the problem perhaps by the end of 1983. In any event the ginnery still operates and maintains the private diesel generators as a standby source of power.

(e) Rabak

Ginnery staff reported that the NEC power supply was fairly reliable perhaps due to the nearby Kenana sugar factory which exports power to the Blue Nile Grid.

Private standby power generation is also available at the ginning factory.

(f) Fau

No substantial difficulties were reported. NEC advised that the 15 MVA transformer at the local substation had been replaced by a 7.5 MVA transformer in order to help with difficulty in procuring transformers elsewhere on the grid. The present maximum demand at the substation was reported to be 6.25 MVA approximately. NEC advised that a 15 MVA transformer would replace the 7.5 MVA transformer in the future but a delivery/commissioning date was not available.

(g) New Halfa

There is a serious problem with reliability of electrical power from NEC at the ginnery. Power is supplied from Khasm el Girba hydro power station which, due to lack of funds and spare parts over several years, has suffered from inadequate maintenance and almost no running repairs. Substantial rehabilitation work is required in order to meet the total electrical load on the network. However, it appears that finance is likely to be available only for the most urgent work in 1983 while the long term rehabilitation required will probably take several years.

During the current cotton ginning season NEC has been unable to supply sufficient power at the New Halfa ginnery and have in fact been importing approximately 1.2 MW of power from the local sugar factory in order to allow New Halfa Corporation to run one ginning factory for 24 hours per day and a second factory for 8 hours from 10 pm to 6 am. Unfortunately the sugar factory normally shuts down for the season at the end of April.

Because of these problems, in late March 1983 two 500 kVA diesel generating sets were delivered to the ginnery. The proposal was to connect each diesel generator individually to one factory as a direct replacement for the NEC power feed. Thus two of the three factories would have their own diesel generator. The diesel generators were to be mounted outdoors adjacent to the appropriate factory.

Hence in the immediate term, the problem of lack of power to the ginnery has been largely solved providing that the diesel generators prove reliable.

(h) Port Sudan

NEC power supply failures at the ginning factory were reported by the ginning staff. In fact there appeared to be an arrangement whereby only half of the ginning factory was operated in order to help NEC meet its overall power supply demand in Port Sudan. However, this has not proved to be a problem so far since the factory capacity far exceeds the present seed cotton production.

NEC at Port Sudan advise that the present difficulty was that of meeting the summer residential demand of 11 MW with a generating capacity of only 4.5 MW. Reliability should increase by the end of 1983 with rehabilitation of Power Stations 'A' and 'C' as indicated in Table 6.2.

(i) Damazin

Ginnery staff reported that NEC power to the ginnery factory was disconnected during the hours of 4 pm to 10 pm each day. Whilst the seed cotton yield this season is not great enough for this to prove a real problem, a more reliable power supply needs to be available. The NEC Area Manager advised that the 11 kV feeder to the ginning factory also feeds the town residential area and is heavily loaded. A solution offered by NEC was to run a separate feeder from an existing 5 MVA station transformer at Roseires power station. However, this matter would need to be pursued formally with NEC and costs and a programme obtained.

6.3 Private Generation

6.3.1 Present Situation

Those ginneries with private diesel power generation are indicated in Table 6.1 and a detailed description of the existing mechanical and electrical plant is given in Annex 1 - Inventory.

Whilst it is to be noted that equipment is old and spare parts are becoming obsolete, generating plant for the most part was found to be of reliable manufacture and maintained in running order.

At some ginneries difficulties were reported in keeping in working order automatic voltage regulation and load sharing equipment, but it was not clear whether this was due to obsolete equipment or lack of specialised maintenance knowledge, and further investigation may be required.

Some difficulty was reported in obtaining diesel fuel (gasoil) from Khartoum, but this did not appear to be of such severity as to affect factory running.

6.3.2 Private Power Generation versus NEC Power Supply

The costs of private diesel generation at the ginneries, particularly for the smaller ratings, considerably exceed NEC tariff charges. The following approximate cost comparison is based on information obtained at Kosti ginnery, relating to March 1983.

NEC tariff charges for March 1983 at Kosti Ginnery
(factory in operation 12 hours/day, 24 days/month)

		LS
Demand charge	225 kVA x LS 1.6	360
Service capacity charge	750 kVA x LS 0.5	375
Actual consumption	37 632 kWh	
	first 30 000 kWh x LS 0.044	1 320
	remaining 7 632 kWh x LS 0.039	298
	TOTAL	2 353

Estimate of fuel costs for March 1983 at Kosti Ginnery if private diesel generation used

(1 Nr VEB Ruston diesel alternator rated at 306 kVA running 12 hours/day, 24 days/month)

		LS
Fuel (aprox.)	100 gals/day x *LS 2.243/gal x 24 days	5 383
Lubricating oil (approx.)	5 gals/day x LS 15/gal x 24 days	1 800
	TOTAL	7 183

Note : * Typical cost for gas oil

	LS/gal
- Gasoil	1.738
- Transport cost Khartoum/Kosti	0.250
- Fees at Khartoum	0.115
- Local fees, etc. at Kosti	0.140
TOTAL	2.243

Substantially increased electricity tariffs were introduced later in 1983, which would approximately double the charges calculated above. However, even after this increase, the cost of fuel is 50% more than the electricity charges. It should also be noted that the above cost comparison takes no account of plant cost, capital depreciation, maintenance costs, spare parts, labour, etc. for private diesel generation. The cost benefits to the ginneries of using NEC power, at least in financial terms, are therefore considerable.

6.4 Proposed Improvements to Power Supplies

6.4.1 Future Power Requirements

The proposed improvements and additions to ginning facilities will significantly increase the electrical power requirements of the ginneries. Table 6.3 shows the estimated installed capacity at each factory before and after improvements and additions. It will be seen that the main increases occur at ginneries that are or will be connected to the Blue Nile grid. Applying a diversity factor of 0.7 to the installed capacity to give the actual peak demand at full production, and assuming that works are implemented according to the programme given in Chapter 7, the future power requirements at ginneries on the Blue Nile grid would be as shown in Table 6.4.

TABLE 6.3

Installed Electrical Power Capacity at Ginning Factories

Location	Factory Nr	Installed capacity per factory (kW) Present	Future[1]
Marangan	1,2,3	500	850
	4	500	850
	11	800	850
	New saw gin factory (2 Nr)	-	800
	New seed treatment plant	-	460
Hasaheisa	5,6	530	850
	7	590	850
	8	530	850
	10	235	300
	12	820	850
	13	245	425
	New saw gin factory (1 Nr)[2]	-	800
Bageir	14	850	900
Sennar	-	450	500
Hamadnallah	-	400	500
Kassab	1	420	850
	2	340[3]	400
	3	800	800
Dueim	-	310	400
Kosti	-	310	400
Rabak	-	500	850
Fau	1	980	980
	2,3,4	830	830
	5	-	900
	Seed treatment plant	410	460
New Halfa	1,2,3	530	600
Zeidab	-	230	230
Port Sudan	-	450	450
Damazin	-	840	840

Notes: (1) Includes effects of planned improvements and additions under GRP.
(2) For Case B. Located in White Nile area under Cases A and C.
(3) No power supply connected at present.

TABLE 6.4

Estimated Future Power Requirements at Ginneries on Blue Nile Grid

Location	Peak demand (kW)(1)						
	1984	1985	1986	1987	1988	1989	1990 onwards
Marangan	1 960	1 960	2 555	3 682	3 927	4 172	4 417
Hasaheisa(2)	2 436	2 436	2 660	2 905	3 637	3 819	4 043
Bageir	595	595	595	630	630	630	630
Blue Nile(3)	315	315	315	315	350	700	700
Kassab	854	1 092	1 092	1 134	1 134	1 435	1 435
White Nile(4)	567	567	567	567	630	875	1 155
Fau	2 717	2 717	3 347	3 347	3 347	3 347	3 347
Damazin	588	588	588	588	588	588	588

Notes : (1) At full production, assuming diversity factor of 0.7.
(2) Includes requirement for new saw gin factory under Case B.
(3) Includes Hamadnallah from 1989.
(4) Includes Dueim from 1990.

6.4.2 Improvements to NEC Power Supplies

From information obtained from the NEC and ginnery staff it is concluded that any unreliability in the electrical power obtained from the Blue Nile Grid and the Red Sea Grid is not a major constraint in the operation of ginning factories. With the completion of Power III Project and the implementation of Power IV Project, reliability should improve and sufficient extra power should become available to meet the increases in requirements described above. Although these increases are large in relation to the present power requirements of the ginneries, they are quite modest in relation to overall demand and projected increases in NEC capacity. Moreover, the main increases do not occur until about 1987/88, by which time works under the Power IV Project should be well advanced. However, demand for electrical power from other consumers is increasing, and negotiations with NEC for further or reinforced power supplies at ginnery locations should commence as soon as project proposals become firm.

Exceptions to satisfactory reliability on the Blue Nile Grid are at Kosti, where the problem should be resolved with local NEC 33 kV reinforcements by 1984, and at Damazin, where a separate NEC supply from the town's residential supply is needed and should be pursued further with NEC.

At Sennar, it is proposed to complete the electrification of the factory, and this will require replacing the existing transformer with one of larger capacity.

Where possible all ginneries should be connected to the NEC power supply and the costs of this have been estimated for Hamadnallah and Dueim. It is assumed that funding for the provision of an NEC power supply to Factory Nr 2 at Kassab is already assured.

There is some uncertainty regarding the availability of power for the proposed 5th factory at Fau. According to NEC in Khartoum, no increase in the present power availability is possible (see Table 6.2). However, from information obtained on site, it is believed that sufficient power should just be available. This matter must be followed up formally with NEC to ensure that adequate power supplies will be available when the new factory is commissioned.

A summary of the works required with estimated costs is given in Table 6.5. It is difficult to predict NEC power supply capital contribution costs as the current tariff requires that an industrial supply applicant shall pay all costs up to and including 11 kV or 415 volt switchgear. This includes the full costs of metering and any link stations beyond the metering point. The cost estimates therefore indicate overall power supply costs only and are subject to further detailed discussions with NEC to determine the extent of NEC work and costs.

6.4.3 Other Power Supply Improvements

The Eastern Grid is unreliable and at New Halfa private diesel generation has been installed on a temporary basis at 2 out of the 3 factories. On this basis various options for consolidation and improvement of the temporary diesel generation installation have been prepared as detailed in Table 6.6. It is recommended that Option 2 is the solution adopted. This allows for the utilisation of NEC power when available or running diesel generators in parallel with a spare unit for standby duty.

At the Nuba Mountains Corporation ginning factories, where plant is driven by diesel engine and lineshaft drives, there is no justification for electrification at the present time. If electrical power was to be utilised at any of these factories it would be necessary to install diesel generators since the Regional Government electrical power supply is limited and unreliable.

6.4.4 Standby Power Supplies

Although it is clearly desirable to have standby generating capacity at ginneries to allow continued operation during power cuts, it is doubtful if the degree of unreliability of the NEC power supplies is generally such as to justify the high expenditure required for new plant other than in the particular case of New Halfa described above.

The ginneries at Kosti and Rabak already have their own generating capacity in addition to an NEC supply. At Hamadnallah and Dueim it is recommended that the existing diesel generating plant is retained for standby duty after provision of the NEC supply. Similarly, at Sennar it is proposed that when electrification is completed an alternator should be added to the existing main drive engine to provide standby power.

The question of providing new standby generating plant therefore essentially concerns the Gezira and Rahad ginneries, which at present all rely solely on NEC supplies.

TABLE 6.5

Proposed NEC Power Supply Improvements

Ginnery	Proposed improvements	FE cost (US$)	Total Cost (LS)
Sennar	Increase of electrical power capacity for ginnery improvements. This includes 750 kVA transformer, LV switchgear, cabling, etc.	36 000	98 000
Hamadnallah	Provision of an NEC power supply including new HV switchgear 500 kVA transformer, LV switchboard, cabling, etc.	40 000	105 000
Dueim	Provision of NEC power supply including HV switchgear, 2 x 500 kVA transformers, LV switchboard, cabling, etc.	63 000	162 000
Rahad	Contingency for NEC capital contribution for power supply to 5th ginning factory (11 kV ring main included in 5th ginning factory cost).	-	10 000

TABLE 6.6

Proposed Improvements to Private Generating Capacity At New Halfa

	Description	FE cost (US$)	Total cost (LS)
Option 1	Provision of 1 x 625 kVA 1 500 rpm diesel generator similar to existing, complete with LV switchgear, cabling, etc. for connection to factory Nr 3. Allowance included for 3 Nr GCI canopies.	84 800	202 000
Option 2 (recommended)	Provision of 1 x 625 kVA 1 500 rpm diesel generator similar to existing. Re-installation of 2 Nr existing diesel generators with new generator complete with automatic synchronising and load sharing, new HV and LV switchgear, inversion transformers, cabling, etc., all in single new generator house. Provision to be made for changeover to NEC supply from HV switchgear.	233 000	584 000
Option 3	Provision of a new diesel generator installation comprising 3 Nr 698 kVA 1 000 rpm Mirrlees Blackstone ES8 turbo-charged 8 cylinder diesel generator sets or equivalent complete with similar ancillary equipment and building as Option 2.	757 600	1 732 000

For the large ginning complexes involved, there would be two basic options :

- to provide individual standby generators for each factory;
- to provide a single generating station for the whole complex.

With both options it would be possible to provide sufficient capacity to run either all the factories or only some of the factories.

The first option would be preferred if only low utilisation was expected. In this case relatively cheap fast-running diesel generating sets could be used. However, if extended periods of operation were envisaged the more permanent type of installation represented by the second option would be preferable. However, in either case the investment would be substantial. For a fully mechanised roller gin factory with an installed capacity of 850 kW, foreign exchange costs for a suitable independent generator set would be about US$ 90 000; thus for the Marangan site, including two saw gin factories, the total foreign exchange costs would be over US$ 600 000. To provide a single generating station to serve the whole Marangan site would cost of the order of US$ 2 million in foreign exchange. It is not considered at this stage that the likely future incidence of power cuts would be sufficient to justify expenditure of this magnitude.

For safety and other reasons, it is nevertheless recommended that there should be standby power for emergency lighting during power failures. Where appropriate, at sites where there is no existing generator, it is proposed that a small diesel generating set should be provided at each factory for this purpose. The locations and estimated costs are as follows :

Ginnery	FE cost (US$)	Total Cost (LS)
Marangan) Hasaheisa) Bageir)	117 000	262 000
Kassab	18 000	38 000
Nuba Mountains	80 000	171 000

CHAPTER 7

IMPLEMENTATION

7.1 Method of Implementation

The project works to be carried out at ginneries can be divided into four main categories:

- major factory modernisation;
- minor factory improvements and rehabilitation;
- general civil and building works;
- construction of new ginning factories.

It would clearly be desirable and most convenient for as much as possible of the project works to be executed directly by ginnery staff (and the producing corporations generally) using their own resources. However, in view of the extent of the works proposed, it is considered that most of the larger works would have to be executed by outside contractors. It is proposed that the arrangements would be as follows.

(i) Major Modernisation Works

These would comprise:

- modernisation of Factories Nr 1, 2, 3, 7, 8 and 13 at Marangan and Hasaheisa;
- modernisation of Factory Nr 1 at Kassab;
- modernisation of Rabak ginnery;
- provision of blending halls at all SGB factories (except Nr 10), Kassab Nr 1 and Rabak.

It is recommended that these major works should be procured on a turnkey basis through international competitive bidding (ICB) or, more probably, limited international tender (LIT). It is envisaged that tenderers would be major equipment suppliers, and that the successful tenderer would employ local sub-contractors to assist with installation of machinery. In the case of the blending halls, supply and erection of the buildings would form a major sub-contract.

If ICB is adopted, great care will be needed in formulating the procurement documents, with adequate guarantees for performance and damages for non-performance. Also, it will be desirable for all equipment of one type to come from the same manufacturer, and having regard to the phasing of the project, the

various packages could be open to tender at the same time with adequate price protection provision. It is recommended that careful consideration should be given to restricting the supply of roller ginning equipment to a negotiated contract with the preferred supplier.

(ii) Minor Works at Existing Ginneries

These would include the various works of overhaul, renovation and replacement of existing equipment and facilities and installation of new equipment at factories other than those mentioned above. These works could generally be executed by the ginneries themselves using their own resources, but where necessary local sub-contractors could be employed, for instance to carry out building repairs or to assist with the installation of machinery. The equipment would be procured through separate supply contracts or, where appropriate to ensure standardisation of equipment (e.g. for seed cotton cleaning machinery), through supply only components of the turnkey contracts for major works. Supply contracts would include for the attendance of manufacturers' installation supervisors where necessary (e.g. humidification systems).

(iii) General Civil and Building Works

These would include:

- roads and hardstandings;
- yard hydrant systems and water supply systems;
- new buildings such as workshops, housing, etc;
- miscellaneous civil works such as weighbridge installations.

These works would be suitable for letting to local contractors on the basis of local competitive building (LCB), with separate supply contracts where necessary for materials and components.

(iv) New Ginning Factories

New ginning facilities would include:

- Factory Nr 5 at Fau;
- a new saw gin factory on either Gezira or the White Nile;
- the Acala seed treatment plant at Marangan.

These would be procured on a turnkey basis, under ICB or LIT procedures, but with a pre-designed component covering the building shell and certain infrastructural items.

General project implementation and procurement arrangements are discussed in the Main Report.

7.2 Implementation Programme

The factors to be taken into account in formulating a programme for implementation of the project works include:

- the timing of requirements for increased ginning capacity to handle projected crop production, taking account of the degree of uncertainty relating to the projections;
- the relative urgency of rehabilitation works to prevent further deterioration of existing facilities;
- implementation capacity;
- the need to avoid undue disruption of operations at existing ginneries.

There would be severe restrictions on the execution of works at ginneries during the ginning season. On the basis of the projections for seed cotton production, it would not be possible to take any factories out of operation for a whole ginning season without causing shortages in capacity. It is also unlikely that ginnery managements would accept execution of works in ginnery yards during the season, although certain works within limited areas could possibly be carried out without disrupting ginnery operations. The basic assumption has therefore been made that most of the works would have to be carried out during the off-season; for this reason it will be necessary to spread the works over a number of years.

The overall project implementation programme is described in the Main Report. 1984 has been designated as Project Year 0, with execution spread over a five-year period from 1985 to 1989. Within this timescale, a programme of works at the ginneries has been drawn up as shown in Figure 7.1. For all ginneries, it is envisaged that spares would be provided as early as possible (1985) to allow overdue maintenance and repairs to be carried out. Particular considerations relating to the programme for each of the producing corporations are described below.

(i) Gezira

A major consideration here is co-ordination with the programme of works to be carried out under GRP. The implementation schedule given in the Appraisal Report (May 1983) indicates that modernisation of existing factories would be spread over five years from 1984 to 1988, with new saw gin factories provided in 1984/85 and 1988. However, this largely overlaps with the implementation period of the CMP. It would seem preferable to concentrate the GRP works in the earlier part of the period, with the CMP works following on. (In fact, the detailed cost tables in the GRP Appraisal Report indicate the works being completed by 1986.) It has therefore been assumed that an integrated programme would be prepared for the works under both projects, as illustrated in Figure 7.1. The main features of this programme are as follows:

- major modernisation works (involving a total of nine factories under the two projects) would be carried out at only one factory per year on each site (Marangan and Hasaheisa);
- GRP modernisation works would be completed by the end of 1986;
- blending halls would be constructed in the same year as other works at the relevant factory;

- having regard to requirements for ginning capacity, the two GRP saw gin factories would be provided in 1985 and 1986; should future production trends require a third saw gin factory, this could be provided in 1987;
- infrastructural (yard) works are concentrated in the first three years to avoid extended disruption.

With the proposed programme, there would be significant shortfalls in nominal ginning capacity (based on 6-day week operation) during 1985 and 1986, but thereafter increases in capacity would more or less match projected increases in production (see capacity models in Annex 8).

(ii) Blue Nile/Suki

There is no immediate pressure on ginning capacity in this area, and there is still some uncertainty regarding plans for rehabilitation of the pump schemes. Works on the ginneries have therefore been programmed mainly for 1987 and 1988, except that rehabilitation works at the Kassab saw ginneries (some of which are quite urgent) and general yard improvements at Kassab are programmed for 1986.

(iii) White Nile

Again, there is no immediate pressure on ginning capacity, and there is uncertainty about rehabilitation of the pump schemes. Works at Dueim and Kosti have been scheduled for 1987. Modernisation of Rabak has been scheduled for 1988, but considering the requirements for increased capacity, it would be possible to spread implementation over two years, with half the factory being modernised in 1988 (including the new press) and the other half in 1989.

(iv) Rahad

In view of the present pressure on capacity, the works at Fau (both works at existing factories and construction of the new factory) are urgent and have therefore been programmed for 1985.

(v) New Halfa

The need for improvements to the power supply is urgent, and is programmed for 1985. Other factory works are not extensive, and are programmed for the same year, but construction of yard works would be spread over two years.

(vi) Nuba Mountains

There is at present no pressure on capacity at these ginneries, and project proposals may have to be reviewed in the light of general agricultural development plans for the area. The implementation programme has therefore been spread over four years from 1986 to 1989, with priority being given to works at Kadugli, Talodi, Kologi and Semeih, which would be carried out in the first two years.

(vii) Other Ginneries

Only minor works are proposed at Port Sudan, Zeidab and Damazin, but it is desirable that some of these should be implemented as soon as possible, and the works have accordingly been programmed mainly for 1985 and 1986.

Figure 7.1

Programme of Principal Works at Ginneries

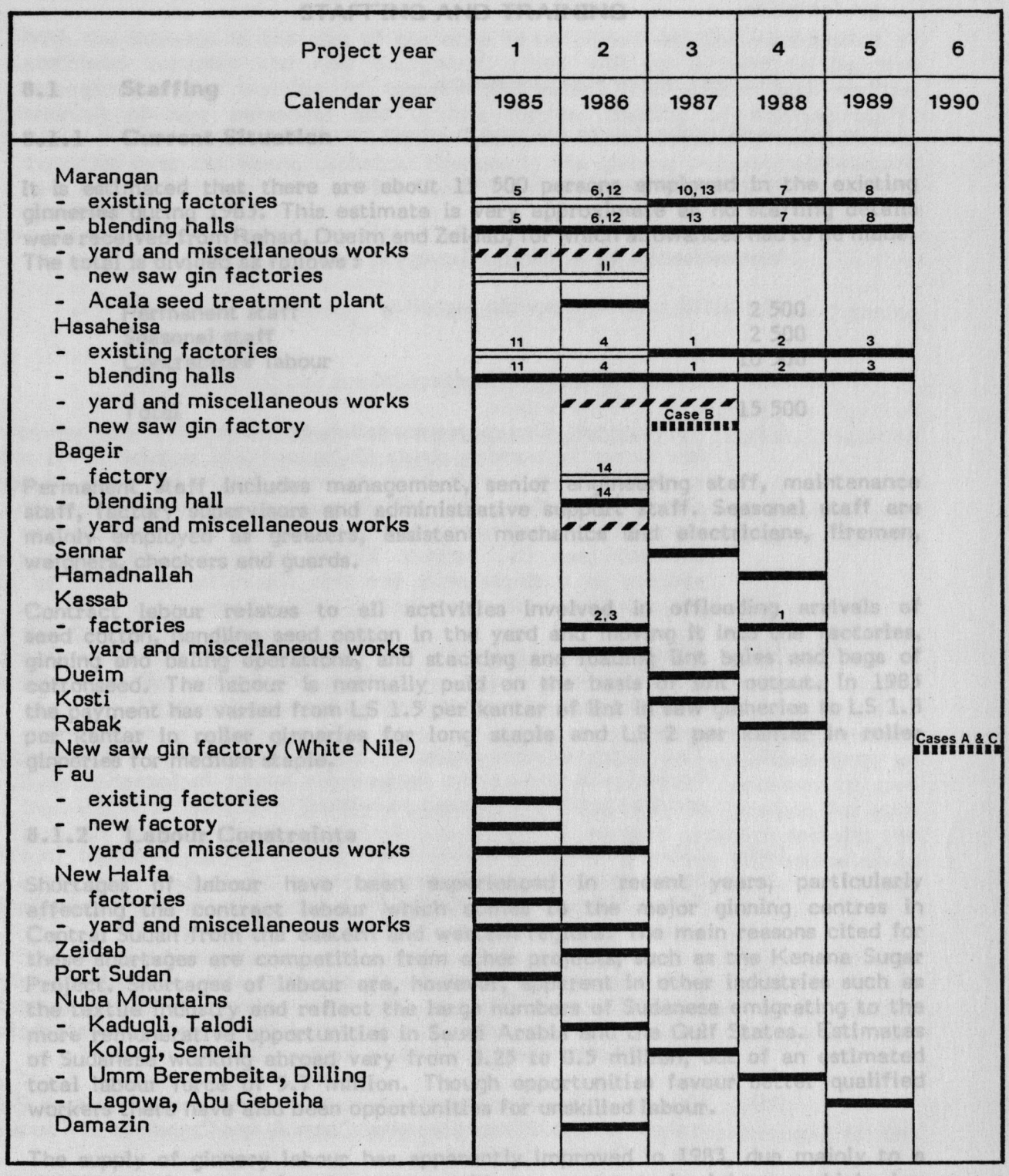
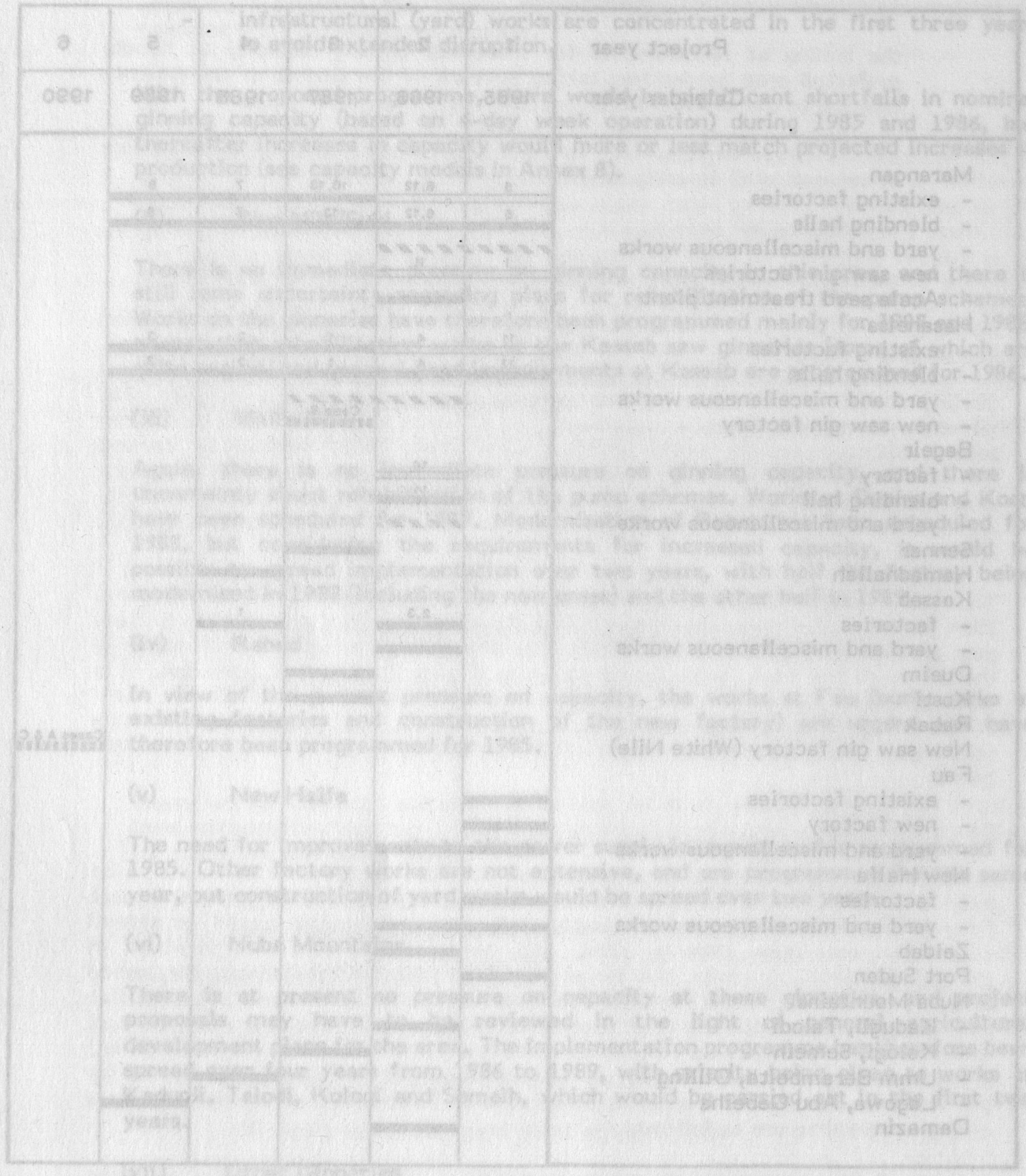


Figure 7.1

Programme of Principal Works at Ginneries



CHAPTER 8

STAFFING AND TRAINING

8.1 Staffing

8.1.1 Current Situation

It is estimated that there are about 15 500 persons employed in the existing ginneries during 1983. This estimate is very approximate as no staffing details were received from Rahad, Dueim and Zeidab, for which allowances had to be made. The total is divided as follows :

Permanent staff	2 500
Seasonal staff	2 500
Contractors' labour	10 500
Total	15 500

Permanent staff includes management, senior engineering staff, maintenance staff, factory supervisors and administrative support staff. Seasonal staff are mainly employed as greasers, assistant mechanics and electricians, firemen, weighers, checkers and guards.

Contract labour relates to all activities involved in offloading arrivals of seed cotton, handling seed cotton in the yard and moving it into the factories, ginning and baling operations, and stacking and loading lint bales and bags of cottonseed. The labour is normally paid on the basis of lint output. In 1983 the payment has varied from LS 1.5 per kantar of lint in saw ginneries to LS 1.8 per kantar in roller ginneries for long staple and LS 2 per kantar in roller ginneries for medium staple.

8.1.2 Labour Constraints

Shortages of labour have been experienced in recent years, particularly affecting the contract labour which comes to the major ginning centres in Central Sudan from the eastern and western regions. The main reasons cited for these shortages are competition from other projects, such as the Kenana Sugar Project. Shortages of labour are, however, apparent in other industries such as the textile industry and reflect the large numbers of Sudanese emigrating to the more remunerative opportunities in Saudi Arabia and the Gulf States. Estimates of Sudanese working abroad vary from 0.25 to 0.5 million, out of an estimated total labour force of 5.7 million. Though opportunities favour better qualified workers there have also been opportunities for unskilled labour.

The supply of ginnery labour has apparently improved in 1983, due mainly to a significant increase in the rate paid to contractor's labour, which has reportedly doubled in some cases. Nevertheless there is still a probable masking of the labour shortage in view of the large number of children employed in certain ginneries, such as Rabak. Labour shortages in general within the economy are expected to continue. A World Bank review of the labour situation suggests that some 360 000 jobs per year will be created up to 1985/86 while only 200 000 persons will be entering the labour force.

Additional problems of labour in the ginneries include contract labourers returning home to their farms before the end of the ginning season and frequent labour disputes leading to stoppages, especially in the labour intensive roller gin factories.

8.1.3 Future Labour Requirements

The factors affecting future changes in labour requirements will include :

- increases in the size of the cotton crop;
- labour savings that may be achieved through modernisation and mechanisation of existing roller ginneries;
- the addition of new saw gin factories

The following particular changes will affect labour requirements :

(i) Rabak, Kosti, Dueim, Hamnadallah, Sennar and Damazin ginneries are currently working single shifts and will require to go onto a permanent two shift basis to meet future increases in seed cotton production. This will increase the demand for contract labour by an estimated 1 420 persons if no modernisation is included (see (iv) below). Zeidab and Tokar ginneries also operate on a single shift but this should be sufficient to gin projected seed cotton production within these areas.

(ii) Kassab Nr 2 is currently not working and awaits connection to the electricity supply. A further 320 persons will be required on a two shift basis when this has been implemented.

(iii) The improvements expected under the Gezira Rehabilitation Project will reduce the demand for labour in factories Nr 4, 5 and 6 by some 560 persons on two shift working.

(iv) Labour savings resulting from improvements proposed in this report relate to six Gezira factories (Nr 1, 2, 3, 7, 8 and 13), Rabak, Kosti, Dueim, Kassab Nr 1, Sennar and Hamadnallah. Total savings are estimated as 2 280 contract labourers.

(v) Two new saw ginneries are to be constructed under the Gezira Rehabilitation Project and estimated additional labour requirements are some 640 contract labourers on two shifts plus about 70 permanent staff and a further 120 seasonal staff.

(vi) New saw ginneries identified in this study include one at Fau and one on the White Nile under Cases A and C and one at Fau and one on Gezira under Case B.

The net effect of the above will be to increase the demand for contractors' labour up to 1990/91 by 180 persons. This figure represents an increase in the demand for contractors' labour of less than 2% from the estimated 10 500 in 1983, while the projected increase in seed cotton production is more than 50%. Seasonal labour requirements meanwhile are estimated to increase by 240 and permanent staff by 140.

8.2 Training

8.2.1 General

With the increase in the size of the crop to be ginned and the introduction of additional capacity and new equipment, there will be a need to improve arrangements for training of ginnery personnel. This applies both to the training of new personnel and to the further training of existing staff. Although the staff of the existing ginneries have developed considerable expertise over the years, technical changes in the ginning industry will require new skills which can only be provided through proper training. In particular, these changes will include :

- greater mechanisation in roller ginning factories;
- increased processing of medium staple cotton in roller ginning factories;
- substantial expansion of saw ginning capacity;
- a possible increase in mechanical harvesting of cotton, requiring additional equipment at ginneries

It is suggested that the new Ginning Inspectorate (see Annex 7) could play an important role in identifying training requirements and co-ordinating training arrangements.

8.2.2 Ginnery Engineers

It is suggested that the future requirements for basic training of new ginnery engineers could best be met by establishing a formal ginning training school or course, with a regular annual intake of suitable candidates satisfying certain minimum requirements. The best solution would be to set up a course at an existing academic institution, which could provide the staff necessary to give instruction in basic and ancillary subjects. The most suitable location for such a course would be in Gezira, within easy reach of the SGB ginneries and also the ARC cotton research laboratory at Wad Medani. In this case the course could perhaps be attached to the University of the Gezira. Alternatively the course could be based at the Khartoum Polytechnic.

It is assumed that whatever institution was selected would be able to provide the basic classroom and other facilities, but a special ginning laboratory would have to be provided for the course. This ginning laboratory would contain ginning machinery and ancillary equipment for demonstration purposes, including:

- a roller gin (Model 2);
- a small modern saw gin (e.g. a 40-saw gin of the type proposed for use as scarto gins);
- at least two hydraulic pumps (one older model, one recent model);
- a small diesel engine;
- electric motors;
- starters, contact breakers, etc. mounted on busbars;

- firefighting equipment;
- textbooks, etc.

Some equipment could be salvaged from existing ginneries being modernised, but some items (such as the saw gin) would have to be purchased new. A provisional sum of LS 185 000 (foreign exchange US$ 75 000) has been allowed in the cost estimates for the acquisition of equipment, plus LS 55 000 (US$ 25 000) for building works.

A tentative syllabus for the sort of course envisaged is set out in Appendix I. It is proposed that the course should be a three-year sandwich course with the trainees' time divided between the school and the ginneries. It has been found from experience there is no point in candidates being given full-time purely academic courses before being introduced to the ginneries. On the job training must be an integral part of the course from the beginning. The roller or saw gin factories used for this training will need to be carefully selected.

Further training of existing personnel who need to enlarge their experience and of selected new trainees who have successfully completed the school course would take place both in Sudan and abroad. In Sudan, training would be arranged at ginneries, especially the SGB roller ginneries at Marangan and Hasaheisa, and could include specialised short courses in particular aspects of ginning machinery or operations. Overseas training for roller ginning could best be provided through experience at ginneries in Egypt. For saw ginning experience and training, it is recommended that there should be visits to installations in nearby countries (such as Turkey, Nigeria or Chad), and a number of staff should be sent on courses in the USA, where visits could be made to ginning equipment manufacturers and the USDA ginning laboratories as well as training at a saw gin plant.

The courses or training for factory engineers and management should embrace all aspects of cotton processing, including cotton cleaning and grading and the uses of cotton fibre.

8.2.3 Ginnery Mechanics

Roller gin maintenance is carried out by gin fitters and carpenters, the latter being mainly concerned with the preparation and condition of the gin rollers. Sudan is fortunate in having skilled gin carpenters and gin fitters, but there should be a programme for training replacements for those lost to the industry through natural wastage or otherwise. The ideal training ground for roller ginning would be at the SGB ginneries at Marangan or Hasaheisa, and in Egypt.

Training of saw gin fitters and operators has been based on the experience of those engineers who had experience with the old saw gin plants and more recently with the installation of a modern plant at New Halfa. From this rather restricted base, saw gin technicians have been trained for the factories at Rahad, Kassab, and Damazin, but with the rapid expansion of saw gin facilities it is apparent that further training in saw ginning is required, particularly with regard to ancillary equipment such as pneumatic conveying equipment, separators, inclined cleaners, lint cleaners, baling presses, etc. This would mainly take the form of organised practical experience at ginneries, but short full-time courses could also be arranged at the proposed new training school.

With the possible increases in mechanically harvested cotton it is essential to train ginnery technicians in the operation and maintenance of mechanical lint cleaners, which are the most effective machine for the removal of the fine, broken-up trash remaining after ginning machine picked cotton. As this is not an easy machine to operate or maintain it requires specialised training, and in addition to practical operating experience at ginneries where these machines are used, training should include visits to the lint cleaner manufacturer.

8.2.4 Overseas Training Programme

The numbers of places per year and estimated costs for the proposed programme of overseas training courses are shown in Table 8.1. This programme would extend for the full duration of the project implementation period. The estimated total annual cost is US$ 133 000.

TABLE 8.1

Programme for Overseas Ginning Training Courses

Type of course	Location	Length of course (months)	Nr of places per year	Cost per place (US$)
Ginnery engineers/ mechanics (roller)	Egypt	6	6	11 500
Ginnery engineers (saw)	Nigeria/Turkey	6	3	12 000
Ginnery engineers (saw/general)	USA	1½	2	8 000
Ginnery mechanics (lint cleaners)	USA	1	2	6 000

8.2.5 Technical Assistance

To assist in establishing the new training course and to coordinate and supervise the training programme, it is proposed that a training officer should be provided under technical assistance through the project for a period of three years. It is suggested that he should be attached to the Ginning Inspectorate rather than to the institution where the ginning course is set up. The duties of the training officer would include:

(a) Arranging accommodation and training facilities for the ginning course.

(b) Deciding on timing and syllabus for the three year course.

(c) Consulting with the various ginning organisations and the government technical schools over recruitment of candidates for the ginning course.

(d) Liaising with ginneries on the allocation of trainees for on-the-job training during the ginning season.

APPENDIX I

DETAILS OF PROPOSED TRAINING COURSE FOR NEW GINNERY ENGINEERS

Admission Requirements

(a) City of Guilds Certificate in Mechanical Engineering, or

(b) Certificate from Government Technical Training Schools or equivalent, or

(c) Existing lower grade staff of above average ability.

Type of Course

Three year sandwich type course with three terms per year, one term per year spent in the ginneries and the other two in the ginning school.

SYLLABUS

First year

First term (3 months)

(1) Principles of cotton ginning machinery (roller and saw gins)

(2) Technical drawing and sketching

(3) The growing, harvesting and processing of cotton fibres

(4) Handling methods (seed cotton, lint and seed)

(5) Seed cleaning, delinting and dressing

(6) The classification of cotton fibre

(7) Management and administration

Second term (4 months)

(1) Planned maintenance (time spent at selected ginneries alongside experienced ginnery engineers)

(2) Stores and administration (time spent at ginneries)

Third term (3 months)

(1) Relative merits of roller and saw ginning

(2) Elementary electrics

(3) Revision of year's work

(4) Written and oral examination

Second Year

First term (3 months)

(1) Electric motors and generators; basic electrical installation

(2) Principles of diesel engines

(3) Principles of hydraulics

(4) Fuel pumps and injectors

(5) Principles of power transmission

(6) Fire equipment and fire fighting

(7) Scales and weighbridges

Second term (4 months)

Ginnery operation and maintenance (time spent at selected ginneries alongside experienced ginnery engineers).

Third term (3 months)

(1) Engines/hydraulics/ginning machinery/other equipment/generating plant: maintenance

(2) Mixing/blending/grading of seed cotton; classing of lint

Third Year

First term (3 months)

(1) problems of the ginnery engineer : open general discussions on problems encountered so far or likely to be encountered in the future in the factory

(2) Ginnery costs - operating (fixed and variable) and capital

(3) Records; log and overhaul sheets; bale and bag markings and recording

Second term (4 months)

(1) Active participation in ginnery operations under supervision at selected ginneries

(2) Planned maintenance (at ginneries)

Third and final term (3 months)

(1) problems of the ginnery engineer : general discussions

(2) Administration and stock control

(3) Course revision

(4) Written and oral examination

Final selection for posting to ginneries or for further experience in other countries.

ANNEX 4

TRANSPORT AND STORAGE

ANNEX 4

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ANNEX 4

TRANSPORT AND STORAGE

1. Introduction

This annex is concerned with the evacuation of cotton lint destined for export and the storage of lint at Port Sudan. Storage requirements at ginneries are discussed separately in Annex 3.

Prompt despatch from the ginneries to the Port Sudan stores is necessary for the following reasons :

- to minimise congestion in the ginnery yards, on grounds of both efficiency and fire risk;
- to obtain a classification of the lint in Port Sudan, after which the bales can be made available for export shipment;
- to reduce the risk of possible rain damage towards the end of the ginnery season;
- to concentrate lint storage in one location in order to facilitate stock control and minimise construction costs for new store requirements, construction costs in Port Sudan being lower than in up-country locations.

Storage in Port Sudan also has the hidden advantage of increasing the weight of a bale through a moisture gain because of the higher relative humidity. This increase in weight is usually some 5 to 8 lb per bale. A limited sample of 2 800 bales weighed at the beginning of May 1983 prior to shipment showed an average increase of 12 lb or nearly 3%.

2. Evacuation of Cotton to Port Sudan

Lint bales were traditionally transported to Port Sudan by rail. However, as a result of operating problems on Sudan Railways and improvements in the road network between Central Sudan and Port Sudan a growing proportion is being transported by road. In 1983, by the end of March 287 000 bales had been received at CPC stores in Port Sudan, of which 100 000 had been transported by rail and 187 000 by road. Only the Rahad ginneries at Fau and the Tokar ginnery at Port Sudan have no access to rail transport. Some intermediate use of road transport is required from the Nuba Mountains ginneries to the store at Semeih and also from Dueim ginnery on the White Nile to Kosti railway station. Nevertheless, the shortages of rolling stock being experienced by Sudan Railways have forced many producing corporations to utilise private road hauliers for evacuating bales.

The cost of road transport is apparently competitive and similar to that of rail. This is because hauliers would otherwise return empty to Port Sudan, their main business being in the reverse direction. A schedule of the current costs of transporting cotton bales by rail from the various ginnery locations to Port Sudan is shown in Table 1.

TABLE 1

Cost of Rail Transport of Cotton to Port Sudan

	LS/bale
Bageir	6.09
Marangan	6.95
Hasaheisa	6.70
Sennar	7.60
Kassab	7.29
Kosti (for Dueim ginnery)	8.23
Damazin	8.84
Semeih (for Nuba Mountains)	9.45
New Halfa	5.35
Zeidab	4.10
Hamadnallah	7.29

Source : Sudan Railways.

Comparative road costs from Marangan site were initially LS 8.5 per bale early in 1983 but later reduced to LS 6.5 per bale against the rail cost of LS 6.95. The economic costs of transport should, however, favour rail.

Shortages of rolling stock on Sudan Railways have been due to a lack of spares. A total fleet of 3 050 freight wagons is presently in operation but a further 1 800 are out of commission. Also 75 locomotives, equivalent to half the fleet, are out of commission. The necessary spares are now on order and are expected to arrive during 1983. An additional 300 wagons are also being purchased from Portugal. Sudan Railways estimate that from next season 70 freight wagons should be made available each day, 7 days per week, throughout the ginning season for the evacuation of bales to Port Sudan. This would provide sufficient capacity to transport over one million bales, on the basis of 100 bales per wagon and a 150 day ginning season. It would then be possible to evacuate the projected number of export bales for 1990/91 during the ginning season with only minor recourse to road transport, except in the case of Rahad and Tokar. Moreover, the number of rail wagons available could increase still further with the possibility of reducing present turn-round times by up to 30%. Given the high proportion of bales already transported by road there would appear to be no major problems in the ability of the transport network to evacuate bales to Port Sudan.

3. Storage at Port Sudan

3.1 Existing Storage Facilities

Storage facilities in Port Sudan comprise 46 covered stores and three open platforms. Details of each store, including present condition and capacity, are contained in Annex 1. This covers only 38 covered stores, which are owned by CPC. The other eight stores are located in a separate complex, and are rented by CPC at a cost of LS 72 000 per year; three of these have been taken by CPC since the field visit of the study team.

The stores are all of a similar size, about 100 m x 40 m with an unobstructed height of about 6 or 7 m. (These nominal dimensions are standard throughout Sudan for all main stores for cotton bales and for general agricultural purposes.) The stores are constructed with steel frames, roof and wall cladding

of GCI sheeting and concrete slab floors. A loading platform is provided where the store is adjacent to a railway line; all the stores owned by CPC have rail access on at least one side. Automatic sprinkler systems are installed in the stores.

Many of the CPC stores require remedial works as indicated in Annex 1, particularly the replacement of valley gutters and GCI sheeting. The cost of these works is estimated as LS 471 000 (FE cost US$ 145 000).

The capacity of each store varies slightly according to its dimensions and also depends on the size of bales contained, e.g. 21 100 Gezira bales or 16 800 Rahad bales. The combined capacity of the 46 stores is currently 880 000 bales which, together with storage of 51 000 bales on the three platforms, gives a total available storage in Port Sudan of 931 000 bales.

The difference in capacity for the two sizes of bales is due to the present agreement covering the labour responsible for handling the bales which limits the stacking height to a maximum of seven bales. This applies both to the Gezira bales, whose nominal vertical dimension is 25 inches, and to the Rahad bales, whose vertical dimension is only 20 inches.

The organisation of the stores at Port Sudan is generally not on a systematic basis, by scheme, variety or grade of lint. This is because stocks have never been sufficiently low to permit such a reorganisation. Stock records of the individual warehouses, however, appear well kept and location of a particular lot (300 bales) is rapid. Management is endeavouring to organise the new stores on a methodical basis for Gezira and Rahad medium staple cotton. This effort was frustrated during 1983 when SGB was temporarily ordered to discontinue evacuation by road and use rail transport.

The new stores are not served by a railway siding so it was necessary to offload Gezira bales from a railway siding elsewhere onto trucks for movement to the new stores, the process incurring double handling charges.

Each warehouse is permanently staffed by a storekeeper and two assistants. Alternatively, there is a senior storekeeper responsible for two stores. Their duties include security, maintaining the stock records, supervising and checking arrivals and shipments, and monitoring distances involved in moving bales for payment of handling labour.

3.2 Utilisation of Existing Storage Capacity

The volume of bales stored in Port Sudan is determined by the size of the physical stock carryover from the previous year and the profiles of arrivals from ginneries and of export shipments. The physical stock comprises both free stocks (bales available for sale) and committed stocks (bales sold and awaiting shipment). The latter have averaged 70% of the physical stock carryover since 1978.

Physical stocks at the year end and annual shipments for the last five years are recorded in Table 2. Over the period the carryover of stocks has averaged 68% of shipments, compared with over 70% between 1971 and 1977, but the level of carryover has increased significantly in the last two years. Long staple cotton accounts mainly for the high level of stocks with an average carryover of 88% compared with 40% for medium staple since 1978.

The monthly profiles of arrivals and shipments at Port Sudan are shown in Table 3, representing a five year average between 1978 and 1982. The majority of arrivals occur between March, a peak ginning month, and August, two months after

the end of the ginning season. Arrivals, however, continue up to the end of the year. Shipments display a more regular pattern during the first nine months of the year but show a peak in the last quarter. The latter reflects increased activity due to the fact that October has been the start of carrying charges for medium staple while December 31st has been the cut off date for payment of medium staple contracts and the start of carrying charges for long staple cotton.

Assuming that arrivals and shipments balance out during the year, the third column of Table 3 illustrates their net effect upon storage requirements. This reaches a peak of plus 20% of annual throughput at the end of September, the start of the rains in Port Sudan. During the current 1982/83 season the stores at Port Sudan were already filled to 95% of total capacity in early May, approximately half of the stock still being carryover from the previous season. This was due to the high carryover, a more rapid expansion of arrivals at Port Sudan and relatively low export shipments. The storage facilities at Port Sudan will therefore be under increasing pressure unless shipments increase dramatically.

TABLE 2

Annual Shipments and Year End Physical Stock at Port Sudan, 1977 to 1982 ('000 bales)

	Physical stock	Shipments	Stock as % of shipments
1978	586	818	72
1979	419	949	44
1980	278	684	41
1981	357	397	90
1982	610	485	126
5 Year Total	2 250	3 333	68

Source : Calculated from data supplied by CPC stores.

TABLE 3

Monthly Profiles of Arrivals and Shipments of Cotton at Port Sudan as percentages

	Arrivals	Shipments	Cumulative position
January	4	8	-4
February	6	9	-7
March	11	9	5
April	13	6	+2
May	11	5	+8
June	11	7	+12
July	12	8	+16
August	10	7	+19
September	7	6	+20
October	6	12	+14
November	4	10	+8
December	5	13	0
Year	100	100	

Note : Based on 5 year average 1977 to 1982.
Source : Calculated from data of Cotton Public Corporation, Port Sudan stores.

3.3 Future Storage Requirements

Future storage requirements will depend on the availability of cotton for export, the level of carryover before a new crop begins to arrive in Port Sudan during January and the future profiles of arrivals and shipments. Formulating assumptions about these factors involves a high degree of risk in estimating the requirements. Past experience of the level of physical stock carryover and the profile of arrivals has not been used as a basis for determining storage requirements. This is because a lower level of physical stock carryover is thought possible in the long term while the future pattern of arrivals should reflect the need to evacuate export bales from the ginneries as quickly as possible and concentrate storage requirements at Port Sudan.

Medium staple exports are expected to form an increasing percentage of total cotton exports. This will assist in reducing the levels of carryover below those experienced in previous years because of the higher turnover of medium staple stock. A comparison of average stock levels as a percentage of exports of cotton of major exporting countries in Africa, the Middle East and Asia over the last five years is contained in Table 4. There is a wide variation in stocks as a proportion of exports, from 18% in Syria to 55% in Pakistan; in Egypt the average was 52%. It would appear a reasonable assumption that Sudan should achieve an average carryover of 50% by 1990/91.

TABLE 4

Stocks of Cotton as Proportion of Exports in Selected Countries 1978/79 to 1982/83

	%
Chad	28
Egypt	52
Tanzania	53
Pakistan	55
Israel	46
Syria	18
Turkey	44

Source : International Cotton Advisory Committee Statistics.

Rapid evacuation of cotton bales to Port Sudan should enable all bales to be received there soon after the end of the ginning season at the end of May. The likely profile of arrivals at Port Sudan is shown in Table 5. The expected arrivals are related to the ginning season extending from the beginning of January to the end of May, allowing for elapsed time in transit and a 10% contingency for late arrivals in July.

Making assumptions on the future level of shipments out of storage is even more uncertain. Ideally marketing of lint to minimise storage requirements should aim to achieve simultaneous peaks of arrivals and shipments. However, it is felt desirable for planning storage requirements to asssume a constant level of sales throughout the year, with a very minor peak in the first half of the year as the carryover stock from the previous year is shipped. This profile of shipments is used in Table 5 together with that of arrivals to determine the peak storage requirement, assuming that overall arrivals equate to shipments.

TABLE 5

Projected Annual Pattern of Arrivals and Shipments at Port Sudan (as percentages)

	Arrivals	Shipments	Cumulative position at end of month
January	10	8	+2
February	16	10	+6
March	16	10	+14
April	16	8	+22
May	16	8	+30
June	16	8	+38
July	10	8	+40
August	-	8	+32
September	-	8	+24
October	-	8	+16
November	-	8	+8
December	-	8	-

Table 5 indicates a peak bale storage requirement, excluding physical stock carryover, for 40% of the export crop of any one year. This peak occurs at the end of July and the requirement progressively reduces towards the end of the year, while there is increased likelihood of rain from the end of September onwards. It is nevertheless proposed that provision should be made for the July peak in determining covered storage requirements. Open storage is not recommended in view of the potential damage from possible early rainfall in Port Sudan during July, as apparently occurred in 1979 and 1980. Also it is unpredictable how long bales may remain in open storage prior to shipment, and open storage does present a higher security and fire risk.

The future availability of bales for export (production less requirements of the local textile mills) is shown in Table 6 for projected production under Case A (production limited to 500 000 bales of long staple cotton and a maximum of 150 000 feddans of med-ium staple cotton grown in the Gezira). The required storage capacity in 1991, equal to 50% carryover from 1990 plus and 40% peak storage of the 1991 avail-ability of export bales, is 1.265 million bales. The storage requirement for Case B, where Gezira is the balancing factor and the pump schemes are devoted solely to long staple, is slightly more, at 1.3 million bales, due to higher Acala production. Case C, restricting medium staple to only 20 000 feddans on Gezira, requires storage for 1.21 million bales.

TABLE 6

Availability of Cotton for Export 1985 to 1991, Case A ('000 bales)

	Production					
	Long staple	Medium staple	Short staple	Total	Local consumption	Availability for export
1985	500	764	62	1 326	100	1 226
1986	500	812	72	1 384	125	1 259
1987	500	860	82	1 442	150	1 292
1988	500	908	92	1 500	175	1 325
1989	500	956	102	1 558	200	1 358
1990	500	1 003	112	1 615	225	1 390
1991	500	1 050	123	1 673	250	1 423

3.4 Provision of Additional Storage Capacity

Existing covered storage facilities have a capacity of 880 000 bales. Covered storage for a further 51 000 bales could be provided by covering the three existing platforms, as they were originally designed to be. The resulting total capacity of 931 000 bales could be increased by 14%, at no extra capital cost, by increasing the stacking height from seven to eight bales. This change would have to be negotiated with the dock labour, and would probably require some extra payment for handling. Although the present limit of seven bales is supposed to be for safety reasons, there seems to be no perceptible difference on these grounds between seven and eight bales. There does not appear to be any limit to the stacking height in the insurance policy relating to the stores. It is said that increasing the stacking height may interfere with the sprinkler systems. It would be necessary to check whether this might be the case in some stores, but it appeared to the study team that generally there should be no problem in this respect. In the case of the 'flat' Rahad bales, it may be possible to increase the stacking height further, to nine or even ten bales, within the same overall height as eight Gezira bales. This could offset any restrictions on increasing the height of Gezira bales in some stores.

Assuming that an arrangement can be negotiated with the dock labour to raise the maximum height to an average of eight bales, the capacity of the existing stores and platforms would be increased to 1 060 000 bales. Additional storage for 200 000 bales is then required under Case A, which would involve the construction before 1991 of 10 new warehouses of the same standard dimensions as those already existing. The requirement increases to 11 new warehouses for an additional 240 000 bales under Case B but reduces to 7 new warehouses for the additional 150 000 bales under Case C. Allowing for the margin of uncertainty concerning the requirements for storage capacity, it has been assumed for the purposes of the project cost estimates that 10 new stores would be provided, regardless of case.

Available space within the existing port area appears to be limited, so the new stores would probably have to be constructed at a separate site elsewhere. It is unlikely that there would be convenient rail access at such a site, and it has been assumed that the new stores would be served by road. Details of a typical store are shown on Figure 1.

The estimated cost of covering the three existing platforms is LS 2 758 000 (FE cost US$ 1 148 000); this includes the cost of completing the concreting of the floors. The cost of a new store is estimated to be as follows:

	FE cost (US$)	Total cost(1) (LS)
Supply of structural steelwork and cladding	348 800	777 650
Erection	-	45 000
Sprinkler system	15 000	50 000
Civil works	118 000	382 000
Total	481 800	1 254 650

Note: (1) Includes taxes and duties.

It is recommended that the construction of the new stores is proceeded with before 1991. This is because storage requirements in the intervening years are liable to be similar to or even above those indicated above for 1991. For example, if a 70% carryover could be achieved by 1985 then the peak storage requirement in 1986 would be over 1.3 million bales for Case A in Table 6.

It is suggested that the provision of any new warehouse storage should be organised on a scheme and variety basis, provided that arrangements can be made to ensure that the expediting of export shipments would not be held up by restrictions on the allocation of handling labour.

4. Handling at Port Sudan

4.1 General

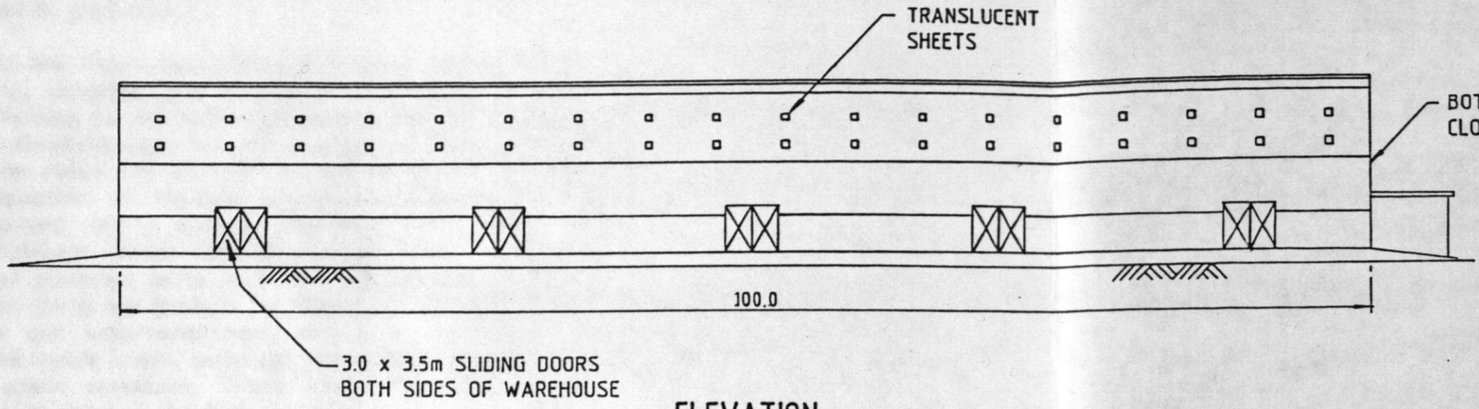
At present, all handling within the warehouses is done manually. This includes offloading arrivals, weighing and shipment. A workers' co-operative has exclusivity for all handling in the cotton warehouses and the port. The cotton storage area is divided into four areas with five groups of eleven workers within each area, giving a total of 220 workers. Group labour cannot be moved between areas. This has not unduly restricted the expediting of shipments because the appropriate lots are often in several warehouse locations among the four areas (storage generally not being organised by scheme and variety).

The theoretical handling capacity of the above labour force is estimated as 36 000 bales per day, each group of eleven workers completing the offloading of a 300 bale lot in less than an hour, usually forty minutes. The heavy nature of the work and the climate, however, would probably limit the practical handling capacity to between a quarter and a third of the theoretical maximum, that is between 9 000 and 12 000 bales per day or between 270 000 and 360 000 bales per month. An examination of monthly arrivals and shipments over the last five years indicated a peak handling requirement of 274 000 bales in August 1982, 77% being arrivals. A handling requirement of over 200 000 was only experienced in two other months during the period. The future profiles of arrivals and shipments described in the previous section would by 1991 require a movement of around 350 000 bales per month continuously for five months. To achieve this would require an expansion of dock labour or the introduction of mechanical handling equipment in the form of fork lift trucks.

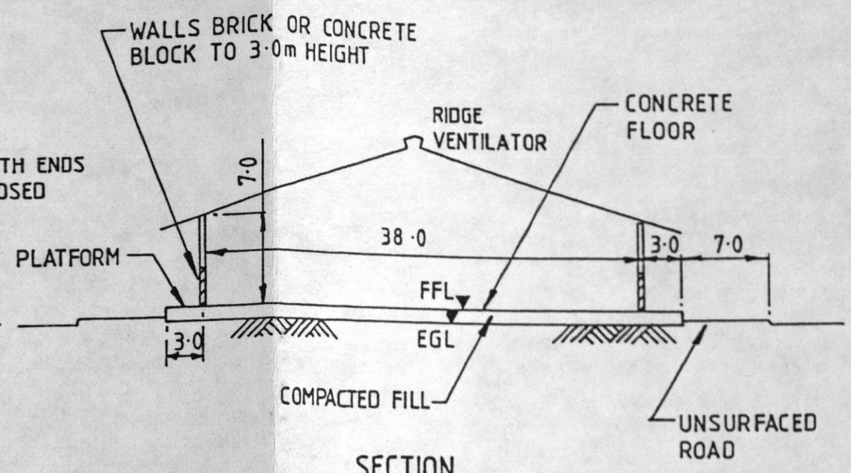
The handling labour is paid on a piece rate system and rates are reviewed every two years. Average handling costs, which include offloading, weighing and despatch, currently vary between LS 159 and LS 223 per 300 bale lot. The lower charge relates to the standard 420 lb bale with offloading from rail wagons and the higher charge to larger size Rahad and Nuba bales and offloading by truck, which is more expensive. Offloading from rail wagons is LS 36 to LS 42 lower per lot of 300 bales than offloading from lorries, the variation again depending on bale size. Arrivals by rail have a further advantage as advance notice of arrival is given two to three days ahead by Sudan Railways. This permits management to plan ahead the deployment of handling labour throughout the stores area. This is not possible with arrivals by lorries because of poor or frequently non-existent communications with the ginneries. The improvements for telecommunications recommended elsewhere should rectify this problem and assist in planning the deployment of labour in the storage area.

Figure 1

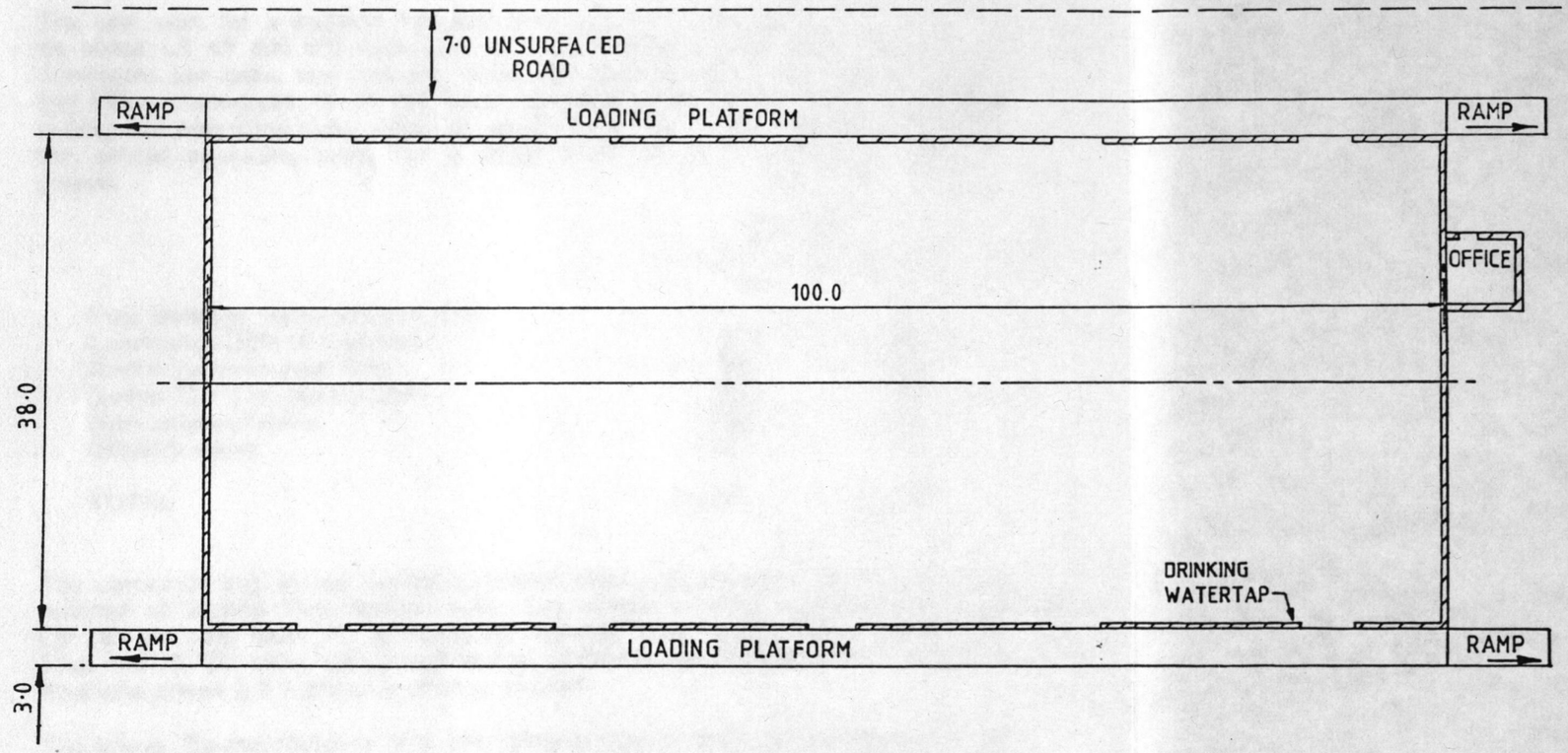
Typical Store (with road access)



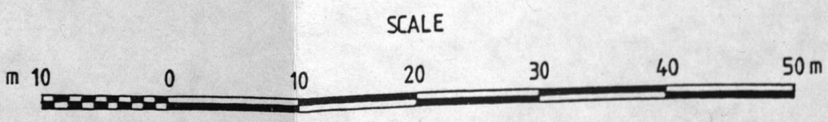
ELEVATION

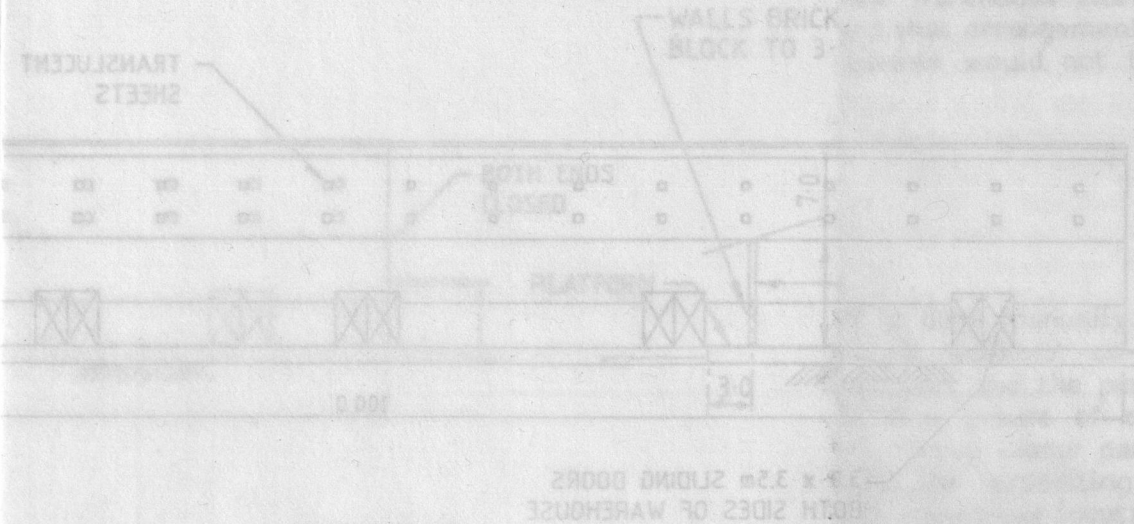


SECTION



PLAN





ELEVATION

UNSURFACED
ROAD

LOADING PLATFORM

OFFICE

LOADING PLATFORM

RAMP

PLAN

4.2 Mechanical Handling

It was indicated in the Inception Report that fork lift handling could be introduced into existing warehouses with only minor civil engineering requirements for ramp access. There is, however, the problem of reaching agreement with the workers co-operative for their introduction which is likely to be strongly resisted. Use of fork lift trucks would therefore have to be phased in gradually.

There are three alternative forms of motive power for fork-lift trucks: diesel engine, propane gas engine or batteries. It is normal for internal use in warehouses to use either propane or battery powered units. However, both these have disadvantages for the application being considered. Propane powered units can be ruled out because of the problems of arranging a supply of fuel. The introduction of battery powered trucks would require provision of charging equipment and a special charging room, which would involve relatively high expenditure unless fork-lift trucks were to be introduced on a large scale. Diesel powered units have the advantages of 25% lower capital costs for the trucks alone and greater familiarity in terms of maintenance. The warehouses are large and well-ventilated, and it is considered feasible to operate fork-lift trucks inside them, although the engines should be fitted with exhaust scrubbers and spark arrestors. These would therefore be the most appropriate type of truck, at least in the first instance.

The unit cost for a suitable fork-lift truck with a triple extension mast would be about LS 49 600 (FE cost US$ 22 000). Taking an average cycle time of 2 minutes per bale, one fork-lift truck per store would be adequate to handle the likely throughput of 25 000 bales per year. With each bale being handled twice, the operating time would be about 1 670 hours per year. On this basis, the annual operating costs for a single truck would be as follows, in 1983 prices.

	Cost (LS)	
	Financial	Economic
Fuel (average consumption 4 l/hr)	2 489	1 408
Lubricants (10% of fuel cost)	248	141
Depreciation (4 year life)	12 400	7 150
Spares (7.5% of capital cost)	3 679	2 145
Maintenance labour	300	180
Driver's wages	1 500	900
TOTAL	20 608	11 924

The corresponding annual saving in labour costs would depend on bale size and method of arrival (see Section 4.1). The average saving is estimated to be LS 185 per 300 bale lot, allowing for arrivals by road and larger size bales. Thus for 25 000 bales the annual saving in labour costs would be LS 15 416 at financial prices (LS 9 250 at economic prices).

The above figures indicate that the introduction of fork-lift trucks would not be financially or economically viable under present circumstances. This conclusion would, however, have to be reviewed should labour rates increase substantially or a serious labour shortage arise. In any case it is recommended that all new storage facilities should be planned to allow for the possible future use of mechanical handling.