League of Arab States
Arab Organization for Agricultural Development
Khartoum

DAMAZIN AGRICULTURAL AND ANIMAL PRODUCTION CO. LTD.
COMPREHENSIVE PROGRESS REPORT

Khartoum, January 1984.
LETTER OF SUBMISSION
Dr. Ahmed Mohammed Ali  
President,  
The Islamic Development Bank,  
Jeddah.

Dear Dr. Ahmed,

It gives me great pleasure to submit to you the comprehensive progress report on the Damazin Agricultural and Animal Production Project (DAAPCO) which we have conducted on your request.

The team concerned has stayed in the field long enough to examine the project assets, to monitor the performance of the ongoing operations, to interview the senior field staff, and to have a personal feel of the agricultural activities performed in the field. In Khartoum the team was able to conduct numerous sessions with the Managing Director and to look into reports and studies made available to them.

The result of all these efforts is the enclosed report which objectively states that the Damazin Agricultural and Animal Production Project is a rewarding endeavour by all standards. Although the current productivity is only half what has been modestly recommended in the feasibility study, it is higher by 28% for sorghum and 64% for cotton than similar projects in the area. The financial analysis shows that the internal rate of return achieved at the present circumstances is about 33%, but this may go beyond the 50% limit if the rotation proposed in the text is adopted. The shareholders are, therefore, advised to pursue the development of the area allotted to them.

However, the scheme was found to be wanting in almost all aspects. The scheme is badly in need of additional machinery, implements and vehicles; the agricultural operations need to be performed at the proper time and according to the recommendations.
of the research people, the management at the field level needs to be supported with trained personnel and provided with incentives; the marketing arrangements should be reconsidered and a marketing unit be created. However, most of these failings may be accounted for by the newness of the scheme, the remoteness of the area and the influence of the current economic conditions in the Sudan.

In submitting this report, I would like to thank you for your appreciated confidence in AOAD and to thank the Managing Director of DAAPCO and his senior staff for their friendly cooperation and generous assistance that enabled the team to compile the report.

Yours sincerely,

Director General

Dr. Hassan Fahmi Jumah
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TERMS OF REFERENCE FOR THE PREPARATION
OF A COMPREHENSIVE FOLLOW-UP REPORT FOR
THE DAMAZIN AGRICULTURAL AND ANIMAL
PRODUCTION COMPANY — SUDAN

1. How far the project objectives have been realized so far in terms of area coverage, cropping plan production target and marketing of output?

2. To assess to what extent large scale crop production under rain-fed condition has proved successful? Has the lack of controlled irrigation posed serious problems in realizing the desired level of crop production?

3. To review and assess the manpower availability, technical and managerial and labour force, given the isolated location and its implication on the overall performance of the project.

4. To review and evaluate the mechanization programme, its strength and weakness with bearing on production target.

5. To evaluate the performance of the crops visualised before starting the project and the crops that have proved successful so far.

6. To evaluate the performance of the export crops viz. cotton, sesame etc. and to identify the problems encountered.

7. To evaluate to what extent the project is being effectively managed with implication on its overall performance.

8. To evaluate the role of foreign experts in efficient management of the project.

- F -
9. Evaluation of the marketing arrangements made so far and problems encountered to it.

10. Evaluation of the possibility of introducing animal production within the company and prospects for such new investment.

* This item was later excluded as requested by I.D.B.
SUMMARY AND RECOMMENDATIONS
SUMMARY AND RECOMMENDATIONS

The Damazin Agricultural and Animal Production Company (DAAPCO) was established in 1976 on the initiative of Prince Mohammed El Faisal. The objectives drawn to exploit the land allotted (258,900 hectares or 621,000 faddans\(^1\)) were far reaching, including the development of production, the conservation of natural resources, the reduction of outmigration from the rural areas, the participation in the rural development of the province, etc..

During the pilot phase it was planned to exploit some 200,000 faddans for the commercial production of cotton and sesame in three phases by the year 1988. However, this plan was modified by the Sudanese management which took over in 1980. For one reason, the expected involvement of other regional and international organizations in the scheme was not realized and the long-term credits for development were not forthcoming. For another, some serious problems have faced the mechanical cultivation of the selected cash crops and, therefore, sorghum (durah) was chosen to dominate the rotation. In the current season, 1982/83 some 87% of the area is covered by this crop.

The team has made an extensive tour to the scheme and was able to make an objective evaluation of the whole endeavour. However, reading through the reports of the past four years one feels that the long-term objectives are not always mentioned when drawing the annual plans, which are naturally influenced by the financial strains and the technical problems encountered. In the process some ambiguity is shed over the ultimate objectives of the scheme, which need to be spelled out in a very clear statement of policy and adhered to.

\(^{1}\) One faddan (fed) is equal to 0.42 hectare.
The team believes that, within the limits of the area developed, it can be said that the project is a worthwhile endeavour. Area-wise what has been developed is about 75% of the total area envisaged for the first commercial phase. This is an impressive record taking into consideration the financial strains which were encountered and the shortages of fuel which were experienced in the country during the past three years. Productivity-wise the yields attained are half what has been stipulated in the original technical report, nevertheless they are higher by 64% for (cotton) and by 28% for (sorghum) than the relevant yields in the mechanized farms in the area. This indicates clearly that the project as a large scale crop production under rainfed conditions is viable. The record could have been more impressive if the recommendations outlined in the technical report concerning the crops and the cropping pattern were strictly followed. In this report two new rotations have been proposed (Chapter III) and the management is strongly advised to adopt them.

From the start it was known that the project is being established in a sparsely populated area and as such all the technical, managerial; and the various sectors of the labour force have to be drawn from other regions. However, the fact that the scheme has now a solid core of the field personnel and a force of more than 5000 persons (during the field visit), performing the various operations, shows clearly that the scarcity of man-power is not an in-surmountable problem; if only some price has to be paid. The wages and fringe benefits that the casual labour are demanding and getting reflect not only the high rate of inflation in the country, but also the scarcity of labour. This is a clear case for the management to maximise mechanization of all agricultural operations, as has been planned in the original studies.
On the other hand, lack of utilities and social services have confined the choice of the technical and managerial personnel among the young bachelors, critically depriving the project of the rich experience of the older generations. Naturally, with the development of the scheme and the provision of utilities such as drinking water, schools, village shops, extensive settlements shall be encouraged and the problem of labour force availability shall not pose prominently.

The mechanization programmes is perhaps the poorest aspect of the project. While the scheme is in need of additional machinery and implements, some of those procured during the pilot stage were both expensive and unnecessary. Some have never been used.

However, the team was informed that 25 Ford tractors (75 h.p.) have been contracted and might be in the field just in time for the new season.

The personnel currently supervising the available machinery and implements can hardly do the job. Therefore, an agricultural engineering department should be created and manned by agricultural, operation and maintenance engineers. The workshop facilities are not adequate and should be supported by a workshop for the vehicles and two mobile workshops for the field machinery. Training in-service or otherwise, should be given high priority as 78% of those engaged in the workshop have never had prior training.

The original long-term cropping plan proposed for the scheme was a 4-course rotation of 25% cotton, 25% oilseeds including sesame, 25% phillipesara and 25% sorghum. In the revised feasibility study made by the foreign management (Dalgety) a totally different cropping pattern was adopted: 55% sesame, 19% cotton, 22% sorghum, 4% sunflower and 1% soyabeans. This plan proved to be over-optimistic as concerns the solution of the problems of mechanical
harvesting of sesame. (See Chapter IV). It also disregarded sesame's adverse sensitivity to delayed sowing, delayed weed control and water-logging as compared to the much hardier sorghum and cotton, which proved to be very successful. In this report a component of research has been proposed (Chapter III) to focus mainly on the technical problems that are related to mechanization of sesame production, the commercial piloting of sunflower, soyabeans, etc.

Till additional cash crops are selected the project shall depend on sorghum, cotton and sesame on varying degrees. For all three crops there are great marketing prospects and the management has encountered no difficulty in marketing all the produce. In the case of cotton a higher price was realized than what has been offered to similar types of lint in the country.

However, as has been indicated in chapter V there is need for the creation of a marketing unit to take care of all the marketing aspects, including research, advertising, promotion and sales.

Although what has so far been achieved is a credit to the young management of the project, this area has been found wanting in many aspects. Despite the fact that in some cases performance is not very much related to age, qualifications and experience; in most cases they are highly related. Therefore, either personnel who are more qualified and experienced be attracted, or a very specific training programme be embarked on to qualify the current personnel. Before the present management an Australian team was in charge. However their obvious lack of experience in tropical agriculture and animal production has led to many drastic changes in the original production objectives (see chapter III) as well as to completely unjustified financial commitments (Chapter IV).
Similar unhappy experiences were repeated with other projects in the Sudan, such as Elseboit, Kardigeil, Kenana Sugar Company at one stage, etc., when the management was exclusively foreign. However, as has been stated in chapter VI it should not be construed that all foreign management is, by definition and in all circumstances, inadvisable.
CHAPTER I
CHAPTER I

1. BACKGROUND:

With the advent of the seventies the international food crisis took a new dimension especially in the Arab World, which has been categorized as the number one food deficit area in the world. On the other hand Sudan has been identified, thanks to the availability of enormous natural resources, as a prospective breadbasket to the Middle East.

All this has prompted Prince Mohammed El Faisal of Saudi Arabia and other Sudanese entrepreneurs to invest in agriculture in the Sudan and to establish the Damazin Agricultural and Animal Production Company Ltd. (DAAPCO) in 1976. However, the objectives drawn for the new endeavour were far-reaching:

1) Develop agricultural production (both plant and animal) in the Sudan to help attain self-sufficiency internally and contribute to the food security of the Arab World.

2) Contribute to the foreign reserves of the Sudan.

3) Participate in the local and rural development of the Blue Nile Province where the scheme lies.

4) Introduce new technology in plant and animal production and boost productivity in the agricultural sector.

5) Contribute scientifically and practically in the conservation and development of the natural resources.

6) Create new employment opportunities and training facilities to help reduce outmigration.
7) Initiate a creative and mutually beneficial relationship between the traditional sector and the rural people on the one hand and the commercial sector on the other.

8) Notwithstanding the above objectives and in spite of the fact that the scheme is considered a pilot experience of the mutual cooperation between the private Arab Sector, in general, and the Saudi sector in particular, and the private Sudanese sector, commercial production and profit remain to be the main guidelines of DAAPCO.

Early in 1977 DAAPCO was allotted 258,960 hectares (621,000 feddans) in the central clay plains of the Damazin district in the Central Region. The area is generally flat with a sloping tendency from East to West and from North to South. The whole area is traversed with seasonal streams which serve as a very important source of drinking water during most of the dry season. As part of the woodland savannah the area is densely covered with acacia trees and a host of shrubs and grasses which are generally utilized for seasonal grazing.

Until 1970 all the area was a land of traditional rainfed agriculture, where sorghum is grown as a staple food and sesame as a cash crop.

However, in 1970 mechanized rainfed farming was introduced and progressively developed to cover more than one million feddans by 1982, mainly as individual schemes of 1500 feddans each.

Simultaneously, extensive areas were being granted to private companies, such as DAAPCO, in an attempt to accelerate the development of the area. It was hoped that the new entrepreneurs shall bring with them new technology and improved practices and revolutionize crop production in the area.
At first a technical team of Sudanese experts, and later
Dalgety agricultural Development International Limited, an
Australian consultancy, were commissioned to undertake and review,
simultaneously, the techon-economic feasibility of the project.
They both recommended the establishment of a first pilot phase
to be followed by a second commercial phase.

Management of the first phase was given to Dalgety who
were requested to investigate and establish all aspects of
commercial cropping and livestock production so that viable
enterprises can be developed.

It was also agreed that only 40% of the land allotted, some
200 thousand feddans, are suitable for mechanized agriculture,
while the balance was to be devoted to livestock production. Then
the following plan of execution was drawn:

6000 feddans (pilot phase) to be developed in 30 months
from November 1977 to 30/4/1980. 64000 feds (first commercial
phase) in 4 years from season 1980/81 to season 1983/84. 70,000
feddans (second commercial phase) in 2 years 1984/85 and 1985/86
70000 feddans (third commercial phase) during the years 1986/87
and 1987/88.

On the finance side the shareholders contributed LS. 3
million Sudanese pounds as equity capital with the intention of
securing enough credit to finance the production operation.
However, all financiers were reluctant to participate in the
project before evaluating the result of the pilot phase.

During the pilot phase Dalgety were to assess the
commercial mechanized production of sesame, cotton and sorghum and to
investigate the technical feasibility of sunflower and soyabean as well as the viability of livestock production on commercial bases.

In the span of the first two years of the pilot phase the total costs, including capital investments and operational expenditure, consumed all the equity. Moreover, Dalgety were convinced that enough information has already been gathered to proceed to the commercial stage. This was planned to cost some LS. 52 million Sudanese pounds over four years. Out of this sum Dalgety were to have taken some 6 million Sudanese pounds in lieu of salaries and remunerations.

However, the Board of Directors did not approve the proposed plan and the contract with Dalgety was terminated in October 1979. It was generally thought that the problems of mechanized production of cotton and sesame were not solved yet and the production plan to devote 50% of the area to cotton and 50% to sesame was not realistic. Moreover, it was thought that the budget drawn by Dalgety makes the cost of production prohibitive.

Dalgety were immediately replaced by a Sudanese management which was faced with the dual responsibility of securing additional finance and proceeding with the preparations for the coming season.

At this stage the Islamic Development Bank became a shareholder, offering LS. 3,150,000 Sudanese pounds to acquire 2000 shares. This was a timely contribution and the new management was enabled to proceed with the development of the commercial phase in the season 1980/81.

As no new additional finance was forthcoming, the Board of Director was forced to increase the original equity capital of LS.3
million pounds to LS. 10 million pounds in 1979 and then to LS. 15 million pounds in 1982.

This has facilitated the development of additional new land and by the upcoming season 1983/84 a total of some 52,000 feds would have been cleared and ready for cultivation—less by 18,000 feds of the total area of the first commercial phase.

Instead of devoting all the area to cotton and sesame according to the plan of execution proposed by Dalgety only 13% of the area shall be devoted to these two crops in the season 1983/84, while 87% shall go to sorghum.

During 1982 DAAPCO commissioned a Sudanese consultancy to investigate the feasibility of integrating animal production into the existing crop production system. However, the main conclusion of the study was to cut off some 130,000 feds of the existing project and apply for a new area of 100,000 feds of irrigable land in Sennar district to establish an animal production complex. It is believed that this recommendation has the general approval of the Board of Directors. Moreover, the general consensus is to confine the present arable land (210,000 feds) to crop production.

In the following chapters we shall investigate closely the developments in the various aspects of the scheme, and give a general assessment of the whole endeavour.
CHAPTER II

LAND DEVELOPMENT
CHAPTER II

2. LAND DEVELOPMENT:

The project area lies in the woodland savannah of the central clay plains which is dominated by acacia species, Balanites egyptica, Hyphaene thebaica Ziziphus spina-cristi, etc.. and a host of shrubs and grasses. The whole area is traversed with numerous seasonal streams which dry up towards the end of the rainy season making drinking water, the number one limiting factor discouraging any large settlements in the area. Therefore, apart from the scattered thinly-populated communities in the project area, believed to total some 2000 persons, all the population in the district are nomads.

In the circumstances the development of the project area necessitated the clearance of trees, the digging of water excavations to store water, the building of housing facilities, the construction of internal roads and the provision of all the necessary social services, as a prelude to economic development. The field visit has indicated that in all these aspects some efforts were expended but more needs to be provided with the passage of time, but at a higher accelerated rate.

2.1. Tree Clearance:

In the plan of execution tree clearance and land development were phased according to the following time schedule:

- 6,000 feds in 30 months (from Nov. 1977 to 30.4.1980)
- 64,000 feds in 4 years (from 1980/81 to 1983/84)
- 70,000 feds in 2 years (1984/85 and 1985/86)
- 70,000 feds in 2 years (1986/87 and 1987/88)
However, due to financial and other technical problems, the rate of execution was far behind schedule as can be seen from the following table:

<table>
<thead>
<tr>
<th>Year</th>
<th>Area Planned for Development</th>
<th>Area Developed</th>
<th>Total Area Actually Cropped</th>
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<tr>
<td>1977/79</td>
<td>5,700</td>
<td>4,460</td>
<td>4,460</td>
</tr>
<tr>
<td>1979/80</td>
<td>10,700</td>
<td>6,000</td>
<td>10,460</td>
</tr>
<tr>
<td>1980/81</td>
<td>17,850</td>
<td>15,600</td>
<td>26,060</td>
</tr>
<tr>
<td>1981/82</td>
<td>17,850</td>
<td>10,000</td>
<td>36,060</td>
</tr>
<tr>
<td>1982/83</td>
<td>17,850</td>
<td>15,000 (Projected)</td>
<td>51,060 (Projected)</td>
</tr>
<tr>
<td>Total</td>
<td>69,950</td>
<td>51,060</td>
<td></td>
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*Source: Report to the Board of Directors, 1983.*

From the above table it is clear that the rate of development during the pilot stage (78%) and the first year of the commercial phase (60%) were not compatible with the targets set in the plan of execution. As a result only 10.5 thousand feds were actually cropped in the first year of the commercial phase instead of 16.4 thousand acres. The pace of development has greatly improved in the following year where 87% of the planned area was developed. However, in the following year the pace slowed down to 56% of the planned area.
In the circumstances, only about 37 thousand feds have been cultivated during the current season which ends in June 83, instead of 52 thousand feds. If the current tree clearance programme is executed as planned it is expected to cultivate some 52 thousand during the next season, instead of 70,000 feds as was stipulated in the original execution plan for phase I.

From the discussions with the management it was made clear that most of the contractors who undertook to clear the trees in the various plots assigned to them were unable to abide by the time schedule for a number of reasons. The scarcity of casual labour was cited as the main reason and the high rate of inflation as a second reason. The contractors have also faced the problems of drinking water during certain months and some of them were obliged to abandon their contracts mid-way.

All this has prompted the management of the scheme to establish its own tree clearance units and undertake the responsibility for developing the greater share of the area planned for development. It is for this reason that it is expected that more than 15 thousand acres shall be cleared this year 1982/83, to be ready for cultivation next season, 1983/84. Out of this area, the scheme units are expected to clear some 11 thousand feds. This was very wise as one of the three contractors who were assigned to clear a fixed area declined after 3 months, when it was too late to contract another.

The rate of inflation and the scarcity of labour have resulted in a sharp increase in the cost of tree clearance. The average cost of clearing one feddan increased from LS. 12.5 in 1980/81 to LS. 22 in 1981/82. This was mainly attributed to both the higher wages demanded by the casual labour and the revenue in kind offered to them during the whole period.
Since 1979 and up to now, Sudan is experiencing a severe shortage of fuel and this has seriously affected all agricultural activities. Drinking water during part of the dry season, has to be transported from distant areas, sometimes as far as Damazin Town (144 km) and this proved to be a stumbling block to other schemes in the area which have no fuel depots. In this respect, DAAPCO has a clear advantage as the requirements of fuel can fairly be planned and procured to sustain the continuation of the necessary activities, mainly tree clearance, during the dry months. It is therefore, recommended that DAAPCO should make use of the experience gained in tree clearance and proceed to clear new areas with its own units. This shall guarantee the timely execution of the operation and reduce the total cost tremendously.

2.2. Water Resources:

In the absence of permanent water resources in project area, the availability of drinking water during the dry season constitutes a serious limiting factor to the development of the scheme. Some effort was done to investigate the availability of underground water and it seems there are conflicting reports on the subject and this calls for additional surveys before this alternative can be considered out.

At present there are three haffirs (water excavations) with a capacity planned to cover the requirements of the first commercial phase. However, this proved to be unrealistic for two reasons. Originally, the scheme was planned to be fully mechanized, but due to various technical reasons

* The study undertaken by Sayed Kheirawi and his team of surveyors indicates the availability of drinking water, while the survey made by Dr. Aaid draws a negative conclusion.
(see chapters III and IV) the scheme is now heavily dependent on casual labour and it shall be sometime before this trend is reversed. Secondly, the inefficiency of the haffir as a water reservoir, due to the high rate of evaporation and seepage, might not have been duly estimated. When the scheme was visited by the team during the month of April all haffirs were dry and the necessary water was being transported from Damazin to cover the needs of more than 5000 persons.

Apparently the existing haffirs need to be expanded and additional haffirs have to be excavated if the project area is to be expanded.

2.3. Office and Housing Facilities:

The office space at the project H. Q. seems to be adequate, the offices are conditioned, providing optimum atmosphere for hard work. The project is linked with Khartoum office with an R. T. (Radio Telephone Service) which facilitates contacts twice daily.

At present there are only 10 houses, a rest house and a bachelor compound at the scheme's head-quarters which are all provided with electricity and running water.

Apart from the rest house, which is meant for guests, these housing facilities are to accommodate the managing director, the site manager and the senior staff. However, at the time of the field visit, the house of the managing director was being utilized to accommodate, temporarily, some of the bachelor staff—a clear indication of the inadequacy in housing facilities. Obviously, the situation will be more acute when the number of senior staff is increased as has been suggested in chapter VI. In addition to this, most of the senior staff in the field are young bachelors who are on their way to marry and that will greatly increase the need for
additional family houses.

The junior staff as well as the labourers are being accommodated in locally made thatch houses. These are cheap and easy to make but need continuous maintenance. From inside, the huts are well aerated and water proof, though fire susceptible. These houses may be suitable to labourers who come from the same region but do not seem to convey the feeling of settlement and permanancy to the staff, recruited from other parts of country. Therefore, a long-term plan should be formulated to upgrade the houses with permanent structures.

2.4. **Internal Roads:**

The project has a small unit of earth-moving machinery (See Chapter IV) for haffir clearing and road levelling. The same unit is used with other units of the local authorities and the Mechanized Farming Corporation to level the road linking the project with the high-way. It is evidently clear that the unit is too small to cope with these activities and has to be enlarged.

2.5. **Social Services:**

The establishment of the project on a virtually un-inhabited area necessitated the provision of all the necessary services to meet the requirements of those working in it. Naturally some of these services are bound to be shared with the local population who are attracted to the project headquarters as an urbanized centre. In the circumstances the project shall be fulfilling one of its main objectives, by contributing to the development at the local level. Already some of the citizens and small scheme owners are making use of the facilities available at the project H.Q., such as the workshop, the clinic, the haffirs occasionally, and the lorries
and trucks on the journeys from and to the project.

Of all these facilities only the services of repair and maintenance workshop are paid for, while the others are enjoyed freely. The workshop is also used to train mechanics and tractor drivers who can later be absorbed in the project or in the nearby mechanized farms.

The clinic was one of the first services introduced, and it is manned by a medical assistant and a trained attendant. The facilities available are adequate to meet only the minor cases, while all other cases are transferred to Damazin Hospital. In the dry season this is a journey of approximately two hours, but during the rainy season only light air crafts can be utilized. Luckily some of the aircrafts engaged in pest control are in the area and they are usually diverted to fly an emergency. The clinic is provided with limited quantities of medicine which is freely distributed. This naturally encourages citizens from outside the project area to make use of the opportunity and this has to be catered for, either in the scheme budget, or from donations from the government or other humanitarian agencies.

With the project entering its fifth year and the number of families expanding, the need arises to establish an elementary school at H. Q. It is expected that the project undertakes the construction of the classrooms and housing compound and contact the concerned Regional Authority to furnish them with teachers and teaching material.

On the religious side it was a good gesture from H. E. Prince Faisal to have established, at his own expenses, a mosque which also serves as a social gathering place. On the other hand, the management has constructed two social clubs, one for the senior
personnel and one for the labourers to relax in the evenings. The rest house is also furnished with a video where selected films are shown on alternate days to men and women.

There is a small police station at the project H.Q. which is the only sign of the government presence in the area, but peace and order are maintained all the same. However, the only crimes which were registered were those of trespassing by nomads and their livestock. Usually the animals are rounded and detained until the owner pays a compensation for the damage done. Failing that, the animals are sold, the cost of the damage deducted and the balance given to the owner. With the passage of time one may expect a rise in the rate of crime and this has to be catered for and tackled with the suitable authorities.
CHAPTER III
CHAPTER III

3. CROPS AND CROPPING PATTERN

3.1. Cropping Pattern in the Area:

The cropping pattern in the area, in both the traditional agriculture and the mechanized rainfed farming, is identical, where only sorghum and sesame are grown. While the subsistence farmer grows sorghum as a staple food and sesame as a cash crop, both crops are grown for cash in a 2-course rotation in the mechanized schemes. According to the approved rotation 750 feddans are to be under sorghum, 375 feddans under cotton and/or sesame, while 375 feddans are to be left fallow.

In practice, and in the absence of strict law enforcement, most schemes grow the whole area with sorghum year after year. On the total an average of 15% of the area is grown with sesame, but this varies greatly from year to year and from scheme to another. This virtual monocropping with sorghum results in a rapid decline of soil fertility and the dominance of sorghum associated weeds. As a result low and unprofitable yields are achieved that farmers are forced to abandon their schemes for good, or leave them under a long fallow to regain their fertility and productivity.

Except for the use of a tractor and a harrow for seedbed preparation and seeding and a grain combine as a stationary thresher for sorghum these schemes are little different from the traditional peasant farms as far as the use of modern technology is concerned. The traditional farmers have the advantage of planting early and getting full benefits of the rains, though increasing numbers of them are giving up this advantage in favour of hiring tractors and harrows to enable them to cultivate larger tracts of land.
Beside the standard mechanized schemes there exist several "companies" which are allotted areas of above 5000 feddans each. They use the same practices as the standard schemes though a few of them grow some cotton.

A major and distinguishing feature of the Damazin Mechanized Farming region is the existence of the big mechanized projects, some actually operating and some only planned and approved. These are projects with a gross area of 100,000 feddans or more. They include the Agadi State farm (200,000 feddans), the Sudanese-Egyptian Integrated Agricultural Company (250,000 feddans) and the Damazin Agricultural and Animal Production Company, the subject of this report. Two other companies were given projects falling into this category but have not started, or are just starting implementation.

These big projects use more advanced crop management and technology. Most tend to use higher power tractors and larger implements. They all use more inputs, especially herbicides, insecticides and fertilizers, and do some research with promising crops and land preparation methods. A final common feature is that all of them produce cotton as a major crop.

3.2. Crops and Cropping Pattern Proposed in the Feasibility Study:

The technical team which undertook the original feasibility study proposed sorghum, cotton, sesame, groundnuts phillipesara, sunflower and safflower as crops to be grown by DAAPCO. It further suggested the possibility of growing maize and soyabeans. It pointed out the difficulties facing the growing or mechanization of some of these and suggested their gradual introduction into commercial production.
In selecting these crops the team was guided by the objectives of DAAPCO, by the limitations of the environment, and the local experience with each crop. A major consideration was that animal production was to be an integral part of the project. This enabled the agronomists to introduce a legume fodder crop, making for a more balanced crop rotation and better soil fertility conservation and sanitation. Animal integration also gave higher values for crops like sorghum by making use of the crop residues.

The team proposed the following crop rotations :-

(i) **2-Course Rotation of** :

50% sorghum , 25% non-leguminous oilseeds , 25% phillipesara and/or fallow.

The oilseeds proposed were sesame, sunflower and safflower.

This rotation was proposed to be followed for the first five years of the project.

(ii) **4-Course Rotation of** :

25% sorghum , 25% non-leguminous oilseeds , 25% cotton :

25% phillipesara and/or groundnuts ( legumes ).

This rotation is a better one agronomically as it minimizes the need for fertilizers and makes for better control of weeds, pests and diseases. It was thought to be more viable and stable economically. However, it was proposed to be adopted from year six of the project. The mechanical harvesting problems of cotton, groundnuts and sesame prevented the adoption of this rotation from the start. Five years were considered adequate to solve these problems with the on-going research efforts and those suggested to be undertaken by the project's own research farm.
In the revised feasibility study made by Dalgety a totally
different cropping pattern was adopted. Sesame was given an
_au:prciminat_ place so that from the third year onwards the following
plan was to be applied:

55% sesame, 19% cotton, 22% sorghum, 4% sunflower.
1% soybeans.

Such a plan is acceptable from a soil fertility point of view
as sesame has been proven to be a very good precursor to any crop.
However, the plan was over-optimistic as concerns the solution of
the problems of mechanical harvest of sesame. It also disregarded
sesame’s adverse sensitivity to delayed sowing, delayed weed control
and water-logging, as compared to the much harder sorghum and cotton.
Finally Dalgety’s sesame yield projections for the first years were
rather inflated and unrealistic, especially with mechanical harvest-
ing. We thus believe that this plan involved much higher risks than
the technical team’s plans.

It should be noted that the Dalgety plan was based on excluding
animal production and, hence, forage crops.

3.3. **Performance of Crops Grown** :

The following Table (2) shows the actual yields (Kilograms per
feddán) achieved by the project for sorghum, seed cotton and sesame
as compared to the technical team (T.T.) and Dalgety’s (D) project-
ions, for the period 1978/79 to 1981/82. Yield records for 1982/83
are not yet complete to be included here. For comparison mean
yields achieved by the rainfed mechanized sector for the whole Sudan
and for Damazin are shown.
### TABLE (2)  ACTUAL AND PROJECTED CROP YIELDS (KG/FED )

<table>
<thead>
<tr>
<th>Season</th>
<th>Actual</th>
<th>T.T.</th>
<th>D</th>
<th>Damazin</th>
<th>Sudan</th>
</tr>
</thead>
<tbody>
<tr>
<td>78/79</td>
<td>477</td>
<td>800</td>
<td>262</td>
<td>286</td>
<td></td>
</tr>
<tr>
<td>79/80</td>
<td>432</td>
<td>840</td>
<td>308</td>
<td>289</td>
<td></td>
</tr>
<tr>
<td>80/81</td>
<td>378</td>
<td>880</td>
<td>288</td>
<td>321</td>
<td></td>
</tr>
<tr>
<td>81/82</td>
<td>405</td>
<td>930</td>
<td>500</td>
<td>427</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>423</td>
<td>853</td>
<td>620</td>
<td>330</td>
<td>331</td>
</tr>
</tbody>
</table>

**Seed Cotton**

<table>
<thead>
<tr>
<th>Season</th>
<th>Actual</th>
<th>T.T.</th>
<th>D</th>
<th>Damazin</th>
<th>Sudan</th>
</tr>
</thead>
<tbody>
<tr>
<td>78/79</td>
<td>319</td>
<td>475</td>
<td>170</td>
<td>144</td>
<td></td>
</tr>
<tr>
<td>79/80</td>
<td>364</td>
<td>490</td>
<td>163</td>
<td>175</td>
<td></td>
</tr>
<tr>
<td>80/81</td>
<td>137</td>
<td>504</td>
<td>181</td>
<td>167</td>
<td></td>
</tr>
<tr>
<td>81/82</td>
<td>318</td>
<td>519</td>
<td>180</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>285</td>
<td>497</td>
<td>174</td>
<td>167</td>
<td></td>
</tr>
</tbody>
</table>

**Sesame Seed**

<table>
<thead>
<tr>
<th>Season</th>
<th>Actual</th>
<th>T.T.</th>
<th>D</th>
<th>Damazin</th>
<th>Sudan</th>
</tr>
</thead>
<tbody>
<tr>
<td>78/79</td>
<td>58</td>
<td>180</td>
<td>91</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>79/80</td>
<td>57</td>
<td>189</td>
<td>118</td>
<td>119</td>
<td></td>
</tr>
<tr>
<td>80/81</td>
<td>127</td>
<td>198</td>
<td>118</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>81/82</td>
<td>150</td>
<td>208</td>
<td>180</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>98</td>
<td>194</td>
<td>240</td>
<td>127</td>
<td>137</td>
</tr>
</tbody>
</table>

Source: Compiled from various reports.

For sorghum and cotton the technical team’s projections were higher than Dalgety’s, while for sesame the opposite is true. Actual yields were much lower than either projection, especially
for sesame and sorghum. Cotton yields were more often higher than Dalgety's estimates but always lower than the technical team's.

For sorghum the average actual yield for the four seasons was, however, higher by 28% than Damazin and Sudan's average for the mechanized sector for the same period. Those for cotton were 64% and 71% higher than Damazin's and Sudan's, respectively, but sesame yield was lower by 23% than Damazin and 28% than Sudan.

We still believe that higher yields could have been obtained under the environmental conditions encountered during these four seasons. Though these conditions - especially rainfall - were often unfavourable, they were not - in our opinion - the most serious cause of yields failing to meet expectations of the feasibility studies. These studies were well aware of the expected variations in rainfall between and within seasons and they made projections for an average season.

In our view the following factors were the main reasons for low yields.

3.3.1. Rainfall:

Table (3) gives the monthly and annual rainfall (in millimetres) for the five years 1978–1982 as recorded at the project's main rain gauge. Monthly rains are also shown as percentages of their year's total while these totals are also given as percentages of Roseris' long-term average annual rainfall. Roseris is about 100 km north-east of the project, but the two are on the same isohyet, generally. Roseris long term (30 years) average are given in the table.

In three years the project's total rains were higher than Roseris and in two they were much lower, making the five years
<table>
<thead>
<tr>
<th>Year</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug.</th>
<th>Sept.</th>
<th>Oct.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>18.9</td>
<td>15.3</td>
<td>149.9</td>
<td>159.6</td>
<td>128.6</td>
<td>264.7</td>
<td>82.5</td>
<td>819.5</td>
</tr>
<tr>
<td>%</td>
<td>2.3</td>
<td>1.9</td>
<td>18.3</td>
<td>19.5</td>
<td>15.7</td>
<td>32.3</td>
<td>10.1</td>
<td>112.6</td>
</tr>
<tr>
<td>1979</td>
<td>26.9</td>
<td>79.2</td>
<td>233.7</td>
<td>85.3</td>
<td>164.7</td>
<td>186.8</td>
<td>49.5</td>
<td>826.1</td>
</tr>
<tr>
<td>%</td>
<td>3.3</td>
<td>9.6</td>
<td>28.3</td>
<td>10.3</td>
<td>19.9</td>
<td>22.6</td>
<td>6.0</td>
<td>113.5</td>
</tr>
<tr>
<td>1980</td>
<td>4.0</td>
<td>37.0</td>
<td>109.3</td>
<td>144.1</td>
<td>76.4</td>
<td>93.6</td>
<td>88.5</td>
<td>552.9</td>
</tr>
<tr>
<td>%</td>
<td>0.7</td>
<td>6.7</td>
<td>19.8</td>
<td>26.1</td>
<td>13.8</td>
<td>16.9</td>
<td>16.0</td>
<td>75.9</td>
</tr>
<tr>
<td>1981</td>
<td>14.0</td>
<td>80.9</td>
<td>49.0</td>
<td>252.0</td>
<td>136.0</td>
<td>173.0</td>
<td>42.5</td>
<td>747.4</td>
</tr>
<tr>
<td>%</td>
<td>1.9</td>
<td>10.8</td>
<td>6.6</td>
<td>33.7</td>
<td>18.2</td>
<td>23.1</td>
<td>5.7</td>
<td>102.7</td>
</tr>
<tr>
<td>1982</td>
<td>0</td>
<td>62.1</td>
<td>51.3</td>
<td>230.5</td>
<td>106.5</td>
<td>37.7</td>
<td>18.0</td>
<td>506.1</td>
</tr>
<tr>
<td>%</td>
<td>0</td>
<td>12.3</td>
<td>10.1</td>
<td>45.5</td>
<td>21.0</td>
<td>7.4</td>
<td>3.6</td>
<td>69.5</td>
</tr>
</tbody>
</table>

Average: 12.8  54.9  118.6  174.3  122.4  151.2  56.2  690.4
%  1.9  8.0  17.2  25.2  17.7  21.9  8.1  94.8

Roseries mm: 11  49  128  152  202  145  41  728
%  1.5  6.7  17.6  20.9  27.7  19.9  5.6
average slightly lower than Roseris. If we consider only the first four years for which we reported crop performance then only one year was lower than the long term average, and these four years average slightly higher than the long term. So it appears that total rain was not a limitation on yields. Even the 553 mm of 1980 could have produced good crops, especially of sorghum and sesame.

Monthly rains are a measure of within-season distribution. Good distribution is often more important than the season's total. Roseris averages represent a good and typical distribution, where the rains increase gradually from April to reach a peak in August and then decrease to a complete stop by the end of October.

A striking feature of the five years rains at the project is the low August rains. In no year was August the peak month. It was the second highest month in one year, the third in two, the fourth in one and even the fifth in one year. In the five years average August was the third highest in rains, out-ranked by July and September. September being a peak month in one year and June in another also seems odd, but it is not unusual for the rains to peak in July.

On the average 52.3% of the annual total rains at the project fell before August, while for Roseris this figure was 46.7% an indication of slightly earlier rains at the project. In addition the total of May and June averages (173.5 mm) at the project should be noted. It is not much different from Roseris.

In general poor distribution of rains within these years seems to have contributed towards lower yields more than did their totals.
3.3.2. **Time of Planting**

Timing of cultural operations, especially that of sowing, has a drastic effect on crop performance. Proper timing, and its manipulation to suit uncontrollable climatic factors, is the most effective means of maximizing benefits and minimizing harmful effects of the environment.

Records of the project we could obtain indicate a tendency towards late planting.

In 1978/79, when the total crop area was about 2500 feddans, sowing dates were acceptable, as all crops were sown by the end of July. However, cotton which should have been the first to sow was the last. In that year rainfall would have permitted all sowing to end a month earlier.

In 1981/82 sesame was sown between July 10 and August 7, cotton between July 11 and August 14 and Sorghum between July 22 and September 11. The following table shows percentages of the season's total rains that had fallen at the beginning, middle and last sowing date of each crop.

<table>
<thead>
<tr>
<th></th>
<th>Beginning</th>
<th>Middle</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sesame</td>
<td>26%</td>
<td>43%</td>
<td>51%</td>
</tr>
<tr>
<td>Cotton</td>
<td>33%</td>
<td>46%</td>
<td>57%</td>
</tr>
<tr>
<td>Sorghum</td>
<td>51%</td>
<td>63%</td>
<td>77%</td>
</tr>
</tbody>
</table>

Rain distribution does not justify much of the delayed sowing. Earlier and well established plants would have better endured the wet July and the dry August. We think that in this season too much rain was allowed to fall before sowing.
In the 1982/83 season sorghum sowing was not started until August 3 and continued to mid-September. All the cotton area was planted during the first ten days of August. Thus 344 mm of rain (68% of total) had fallen before any sowing was started. This was too much delay, especially when we consider the unusually dry September and October that followed. It was mainly failure in these two months rains that made 1982 the driest in the project's history. In this year, more than in any other, crops would have benefitted from earlier sowing. Records indicate that the higher yields were obtained from the earliest sown fields.

No records could be obtained for the 1979/80 and 1980/81 seasons for a review of their sowing dates. However, from records of the remaining three seasons we tend to conclude that delayed sowing - irrespective of its causes - was the single factor which contributed most to low yields. Besides its direct effects it resulted in delays in other operations like weeding and harvesting. The only possible benefits of delayed sowing is that it allows all the weeds to germinate and be destroyed by pre-sowing ploughing and harrowing, if that can be done properly. However, too often these weeds get the chance to grow too thick and tall to be destroyed.

3.3.3. **Time of Weeding**

Crops are very sensitive to weed competition especially during their juvenile stages. Competition effects are more severe when soil moisture or nutrients are limiting. Well grown crop plants can better compete with weeds and smother them. It is, therefore, recommended to complete the first weeding within 2 - 3 weeks after crop emergence and to make a second weeding 2-3 weeks after the first. The use of good herbicides pre-emergence or pre-sowing needs a supportive hand or mechanical weeding 3-4 weeks later. All this assumes that sowing is done on a weed-free seedbed.
In 1978 weeding is reported to have continued from August 16 to October 8 with only one tenth (250 feddans) of the total area receiving a second weeding. If fields were weeded in the same time sequence as they were planted, then weeding would have been done 40 - 69 days after sowing. This is very late.

In 1982 sorghum sowing started on August 3, but weeding started more than a month after this. On September 15 about 35% of the sorghum area of Division 2 of the farm was still unweeded. A week later there was still 23% of this area to be weeded. Individual field records for this section show that first weeding was done after 32 - 54 days after completion of sowing.

If these two seasons are representative of other seasons, for which we got no records, then we have to conclude that weeding was harmfully delayed. This definitely affected yields adversely.

3.3.4. Crop Stand Density

There are few references in the project's records to crop plant populations. In a few instances records indicate very dense population that no yield was expected and the concerned fields had to be abandoned. High populations are more hazardous with late sowing and the resulting limited soil moisture at the late growth stages of the crops.

Sampling made in 1980 - to estimate expected sorghum yields on the basis of plants and heads per feddan - show a great variation among fields. Fields with as little as 3,000 and as much as 55,000 plants per feddan were reported. In all the fields, expect one, there was tillering. This indicates that even with late sowing there was some excess moisture to induce tiller, i.e. that the crop stand was not dense enough. Highest grain yields were obtained from the field
with highest plant population.

Yields seem to have often been affected by too dense or too thin crop stands. Beside seeding rate, seed placement, weed competition, seedbed preparation, soil moisture and pests and diseases are factors that affect crop density. Any one or more of these may have influenced the densities realized at the project.

3.3.5. Time of harvest

Delayed sowing results in delayed crop maturity and harvest. If the 1982/83 season is an indication, then, there was even more delay in harvesting mature crops. Sorghum and cotton harvest was not yet completed at the beginning of May 1983. In sorghum most of the plants were lodged or broken. Even with manual harvest this delay should cause some yield losses in any crop.

There is also a loss in produce quality of crops left standing in the field much after ripening. Sorghum grains tend to break or crack more on threshing because of their being very dry. Cotton lint loses its strength, colour and instre.

When planted early at the project, sorghum harvesting should be complete by the end of December and that of cotton by the end of January. Early sown sorghums can be combine harvested at this time with no difficulty. Lodging would be negligible even with varieties susceptible to the charcoal rot disease.

With cotton defoliation prior to mechanical harvesting becomes inefficient with the low relative humidities expected with delayed harvest.

In conclusion we believe that crop management was not up to the
standards visualized by either feasibility study, though it was much better than in most mechanized schemes. Shortage or delay in supply of necessary inputs is the most apparent cause of sub-optimal crop husbandry. In no way is this a reflection of the quality and ability of the project's top management.

3.4. **CURRENT CROPPING PATTERN**

Table (4) shows the project's crop composition during its five years of operation. Crop areas are given as percentages of the total cropped area in each year. Total is in feddans.

<table>
<thead>
<tr>
<th>Season</th>
<th>Sorghum %</th>
<th>Cotton %</th>
<th>Sesame %</th>
<th>Others %</th>
<th>Total (fed.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978/79</td>
<td>34.7</td>
<td>27.5</td>
<td>33.5</td>
<td>4.2</td>
<td>2475</td>
</tr>
<tr>
<td>1979/80</td>
<td>39.0</td>
<td>30.3</td>
<td>28.0</td>
<td>2.7</td>
<td>4460</td>
</tr>
<tr>
<td>1980/81</td>
<td>32.0</td>
<td>40.6</td>
<td>25.9</td>
<td>1.5</td>
<td>8120</td>
</tr>
<tr>
<td>1981/82</td>
<td>50.0</td>
<td>38.3</td>
<td>11.2</td>
<td>0.5</td>
<td>23086</td>
</tr>
<tr>
<td>1982/83</td>
<td>87.5</td>
<td>11.1</td>
<td>1.1</td>
<td>0.3</td>
<td>37740</td>
</tr>
</tbody>
</table>

* Experimental Crops (sunflower, soyabean, guar, maize etc.)

Sesame's share of the crop area decreased year after year. Its area increased steadily from 1978/79 to 1981/82 but at a much lower rate than the increase in total area. In 1982/83 its area dwindled to 420 feddans, just about one half its area in 1978/79.
The percentage of area sorghum occupied remained practically steady up to 80/81, but increased sharply in 1981/82 and still more sharply in 1982/83.

Cotton's share of the area increased gradually from 1978/79 through 1980/81. It decreased slightly in 81/82 and drastically in 1982/83. The decline in cotton's area is partly due to harvesting problems but is mainly due to ginning problems. Any expansion in cotton area has to depend on mechanical harvesting. The project cannot afford to bring the thousands of labourers - and their families needed for hand picking. Their collection, transport and providing them with water is beyond economic limits. On the other hand, mechanically harvested cotton needs ginneries with pre-cleaners. The Damazin ginnery is without a pre-cleaner - at present - and cotton harvested with strippers had to be taken to Rahad Scheme for ginning in the past years. Cost of transportation to Rahad proved to be prohibitive.

Thus - unless efforts succeed in providing Damazin with a pre-cleaner - cotton area would stay at its present 4-5 thousand feddans. Of the total crop area of 70,000 feddans expected for 1983/84, cotton will then represent a maximum 7%, virtually leaving all the remaining 93% under sorghum. This means that sorghum should be grown on any piece of land for 13 consecutive seasons and to cotton only on the 14th season. In practice this is a sorghum monocropping system which cannot be sustained for long. It will not be just a problem of soil fertility, but the weed problem will be the most serious. The parasitic weed “buda” (Striga hermonthica) associated with sorghum will most probably dominate. If it does, the only known way out is to abandon sorghum growing.

If sorghum remains at its 1982/83 share of 87.5% it has to be
grown continuously for seven years on any field. Even this is highly hazardous. Any system where sorghum occupies more than 50% of the project's crop area will lead to almost complete failure of the project. Yields will decline and/or cost of fertilizers and weed control will increase to render sorghum production an uneconomic undertaking.

It is highly probable that the cotton ginning problem will be solved. That will induce an increase in cotton area to, perhaps, 50% of the cropped area. Cotton will thus alternate with sorghum in a 2-course rotation. Such a rotation should greatly ease the weed problem, as compared to a plan where either crop is grown more frequently. However, still great attention should be given to *striga* and its possible spread.

Cotton and sorghum are both highly soil fertility depleting. In a series of crop sequence trials at Tozi, involving several crops, sorghum and cotton had the worst effects, on succeeding crops. If these two crops alternate they shall therefore inflict harmful effects on each other and on the soil.

Intensive cotton growing would lead to a build up of its insect pests, with an increased cost of pest control and lower potential yields.

Thus a cotton/sorghum rotation will require high inputs of fertilizers and insecticides to insure acceptable yields. The cost of such inputs may prove uneconomic.

3.5. RECOMMENDED CROPPING PATTERN

We are convinced that the current cropping pattern cannot be sustained for long. So alternatives should be sought. With animal
production taken out of the project, or transferred to another site, plans including forage legume production should be ruled out.

Any new cropping plan should be based on a lesser share for sorghum and cotton. Ultimately their combined share should not exceed 50% of the total crop area, preferably with 25% of each. For a few years a plan where they together occupy up to two thirds of the area can be adopted. That is to start with the following 3-course rotation:

½ sesame & other oil crops : ½ cotton. ½ sorghum

In this rotation the sorghum coming after cotton should receive a dose of nitrogen. Ultimately a 4-course rotation, like the following, should be applied:

¼ sorghum : ¼ sesame : ¼ cotton : ¼ soybeans (or other legumes)

To apply either rotation, solutions should be found for problems facing the production of crops other than sorghum and cotton. First a real effort in mechanizing sesame harvest should be made. This involves adapting the present shattering types for combine harvesting, in the short run, and developing non-shattering types in the long run. Secondly, efforts to accelerate the introduction of profitable new crops, such as soybean and sunflower, should be made and supported.

Failure to introduce other crops would necessitate the introduction of a fallow phase in either proposed rotation. By increasing yields per feddan and decreasing cost of production of crops, a well managed
fallow, we believe, would more than offset the decrease in total crop area.

3.5.1. The need for research: To make any cropping pattern viable and to enhance productivity and minimize cost of production, research is essential. The project should undertake and sponsor research which serves its needs. Alloting 1-2% of its annual budget for research is a minimum requirement, and will definitely pay. The project should have one university graduate full-time in charge of research, assisted by some technical staff. His duty will be to execute and supervise research projects designed by specialized consultants, who would also analyse and interpret results.

The project should further encourage and give assistance to researchers who wish to conduct on its farm investigations which are of practical use to the project. In addition it may give financial support to such investigations even if done away from its farm.

Research priorities should be laid out by the project and its consultants to serve the project primarily. Priorities should be based on the importance of the problem investigated to the project and the expectations of its solution by research. For the immediate future, for example, top priority should be given to the complete or partial mechanization of harvest of shattering sesame varieties. Breeding of non-shattering types is not expected to yield quick results and should, thus, be given a lower priority. Determining the cultivars of soyabeans, sunflower and maize best suited to the project's environment and their agronomic and other production requirements should receive a high priority. The same degree of priority should be given to herbicides research and, perhaps, the economic use of fertilizers.

3.5.2. Record Keeping:

The farm should keep detailed records, for each field, of all
agricultural operations and major environmental factors that affect
crop performance. This should be a matter of routine for which
simple recording forms can be designed. Such records, on scrutiny,
can yield results as good as planned research findings. This study
would have been much more useful and definite in its conclusions if
records of such type and standard were available. However, such
records were lacking, though the 1982/83 reports made a very good
effort to produce better records.

3.6. PESTS AND DISEASE

3.6.1. Insect Pests: In cotton the most serious insect pests
encountered were the American bollworm, the flea beetle and thrips.
White fly and cotton leaf worm are reported as lesser pest. With
expansion in cotton area the general insect problem is apt to become
more serious and the relative importance of pest species may change.

During the project's five operating years cotton insects were
brought well under control by the company contracted for the job.

In sorghum there are no records of serious insect damage, though,
with so late sowing dates as used in the project, high infestations
would be expected. The most serious sorghum field insects are the
stemborers, the dura midge and the central-shoot fly. All these (as
well as quelea birds) could be evaded by early sowing. Chemical
control of insects of a low value crop like sorghum is not economic
and, with insects like stemborer, ineffective.

The sesame crop in 1978 suffered severely from infestation by the
sesame webworm. All the introduced varieties, except Maporal, were
highly susceptible to this insect. The Sudanese variety A/1/10
( = Zira'1 l) was not much affected. It is apparent that there are
varietal differences to the degree of infestation with this insect.
This is in line with observations recorded at the Gezira Research Station where infestation in ten varieties from California was ten times as severe as on the local a/1/10.

Use of chemicals to control the webworm on sesame may not be economic and, perhaps, dangerous to use on a food crop. This insect can also be evaded by early sowing. That combined with resistant varieties should be the basis for its control.

The sesame seedbug is a serious pest if given the chance. Luckily it is easily controllable by dusting around sesame shocks in the field and around stored sesame with cheap, and safe, BHC compounds.

3.6.2. **Diseases**: The cotton variety grown at the project, BARAC 67 (B), is resistant to blackarm, the most serious cotton disease under high rain conditions.

There are no sesame varieties resistant to, or a known chemical control for, sesame psuedomonas or cercospora diseases. These diseases usually come at the later stages of the crop growth, and their effect on yield is believed to be not great.

The most known sorghum diseases are the different smuts. They are, however, controllable by simple seed dressings, which are routinely used by the project authority. Charcoal rot is a less known disease of sorghum in the Sudan. It seems to have very little, if any, effect on yield, but it is very serious where the crop is to be combine-harvested. The disease causes severe lodging, as it weakens the lower internodes of the stem. Lodged plants have to be manually harvested, or the combines have to be provided with special lifter attachments.

There is varietal resistance to charcoal rot, but the two
varieties most grown in the project (Gadam El Hamam 47 and Dabar 1) are susceptible. Heavy lodging, due to charcoal rot was experienced with these two varieties grown in the project. We believe this is a result of late sowing which subjects the crop to water stress at the reproductive stages of growth. The disease will infect only a crop which undergoes water stress at these stages. In more than 15 years of developing and testing Gadam El Hamam and Dabar at research centres, charcoal rot was never observed to infect them. That is, most probably, due to the fact that they were always early sown and did not suffer from water stress. Their susceptibility became evident only under commercial production.

As no chemical control is known for charcoal rot its control should rely on the use of resistant varieties and/or early sowing.

3.6.3. Weeds: The most serious pests at project are the weeds. Generally, they affect yields more than all other pests and diseases. At present grass weeds dominate. With continuous cultivation broad-leaved weeds will become more prominent and the relative importance of species within the grasses will change. Persistent species, such as Dinebra retroflexa and Ischimum afrum, now of no importance, shall become a menace.

Research has shown that for rainfed crops started on a weed-free seedbed all weeding should best be completed within the first six weeks after sowing. Two weedings, at equal intervals, within this period were the most economic. The feasibility study’s recommendations were based on these and other findings others on herbicide use.

Several herbicides are approved for use on cotton in the Sudan, and one is approved for sorghum. Two herbicides (Dual and Maloran) and their mixtures (Maloran Special) have given very good results on
sesame under research, but none of them have yet been approved officially.

The project has used herbicides on a commercial scale on all crops with satisfactory results. However, most of the area is still hand weeded. Dependence on manual weeding is perhaps the main reason for the much delayed weeding referred to earlier. Herbicides should be used for all crops to give them a good start. They can then better tolerate any delay in the supportive weeding needed even with herbicides.

The recommended crop rotations should make herbicides more effective. Herbicides are selective in their weed kill and the frequent use of any one herbicide gives a chance to non-sensitive weeds to dominate. Alternating crops allows alternating herbicides to control a wider range of weed species.

For the supportive weeding recommended with herbicides the project should try to make maximum use of the possibilities of inter-row cultivation. This should minimize the need for labourers for hand weeding. Inter-row cultivation requires planting in adequately and evenly spaced rows, trained tractor operators and early sowing. With late sowing the soil is usually too wet and sticky to allow use of tractors and implements.

The use of effective post-emergence herbicides for supportive weed control should be investigated. Such herbicides should obviate the need for any manual or mechanical supportive weeding.
CHAPTER IV
4.1. FARM MECHANIZATION DURING THE PILOT STAGE OF THE PROJECT:

Due to the unavailability of agricultural labour, needed to develop extensive areas and carry out the various land preparation operations for all cash crops, the technical report, prepared by the technical committee in 1977, proposed the establishment of a completely mechanized 6,000 faddams pilot farm. The following mechanical operations were to be adopted as advised by the technical report:

1. Post-harvest tillage and mulching
2. Pre-sowing weed control and seed-bed preparation
3. Crop planting
4. Inter-row cultivation
5. Pest control
6. Grain harvesting

The technical report also assumed that spraying of pesticides will be done by airplanes and that chemical fertilizers will not be used and hence equipment for fertilizer application were not considered.

On reviewing section III - Agricultural Machinery Evaluation - of the Dalgety operation programme (1978), it was noticed that Dalgety management consultants were to conduct large scale performance tests for different types and sizes of tractors and machines, in order to enable them - the management consultants - to support with factual data subsequent machinery purchase recommendations for the later development stages. The operation plan also
<table>
<thead>
<tr>
<th>Tractor make and model</th>
<th>H.P.</th>
<th>Quan.</th>
<th>Yr. Purchase</th>
<th>Condition</th>
</tr>
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<tbody>
<tr>
<td>Versatile - 935</td>
<td>330</td>
<td>2</td>
<td>1977/78</td>
<td>Operating: 1</td>
</tr>
<tr>
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<td>250</td>
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</tr>
<tr>
<td>Allis Chalmers - 7045</td>
<td>150</td>
<td>1</td>
<td>&quot;</td>
<td>-</td>
</tr>
<tr>
<td>Case - 2470</td>
<td>176</td>
<td>1</td>
<td>&quot;</td>
<td>-</td>
</tr>
<tr>
<td>Ford-5000</td>
<td>74</td>
<td>5</td>
<td>1978/79</td>
<td>-</td>
</tr>
<tr>
<td>B. Leyland 727</td>
<td>90</td>
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<td>&quot;</td>
<td>-</td>
</tr>
<tr>
<td>M.F. 290</td>
<td>250</td>
<td>1</td>
<td>1978/79</td>
<td>-</td>
</tr>
<tr>
<td>Allis Chalmers - 8550</td>
<td>330</td>
<td>1</td>
<td>1979/80</td>
<td>1</td>
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<tr>
<td>Versatile fiat 4433</td>
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<td>3</td>
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<td>2</td>
</tr>
<tr>
<td>Case - 2590</td>
<td>74</td>
<td>5</td>
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<td>3</td>
</tr>
<tr>
<td>Ford-6600</td>
<td>90</td>
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<td>Massey-Ferguson 290</td>
<td>72</td>
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<tr>
<td>David Brown 1210</td>
<td>71</td>
<td>1</td>
<td>&quot;</td>
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<tr>
<td>Ebro-470</td>
<td>150</td>
<td>4</td>
<td>1981/82</td>
<td>2</td>
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<tr>
<td>Case 2390</td>
<td>330</td>
<td>2</td>
<td>&quot;</td>
<td>2</td>
</tr>
<tr>
<td>Fiat Versatile 4433</td>
<td>250</td>
<td>2</td>
<td>&quot;</td>
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<tr>
<td>Allis Chalmers 8550</td>
<td>74</td>
<td>7</td>
<td>&quot;</td>
<td>3</td>
</tr>
<tr>
<td>Ford 6600</td>
<td>70</td>
<td>3</td>
<td>&quot;</td>
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</tr>
<tr>
<td>Leyland 702</td>
<td>90</td>
<td>5</td>
<td>&quot;</td>
<td>-</td>
</tr>
<tr>
<td>Massey Ferguson 290</td>
<td>90</td>
<td>5</td>
<td>&quot;</td>
<td>-</td>
</tr>
</tbody>
</table>
called for the purchase of three ranges of tractor h.p. namely, 330, 250 and 220 h.p. with heavy primary and secondary tillage implements. The following comments regarding the farm mechanization during the pilot stage should be considered :-

1) Refering to Table (5) the management consultants purchased 14 tractors with horse powers ranging from 330 to 71 h.p. and of 6 different makes and origins. Four of the tractors (28.6%) are functioning, five (35.6%) need repair and five (35.6%) are inoperable. Three makes namely, Case 2590, Allis Chalmers 7045 and Case 2470 are of close range of h.p. 180, 150 and 176 h.p. respectively; one tractor in this range of h.p. could have been adequate. The total number of tractors is thought to be extremely high for piloting trials. The variability of tractor makes and origins and the technical sophistication that characterized most of them resulted in:

a) Un-necessary increase in the fixed costs of the piloting stage. It is worth mentioning that the management consultant were also the sole agents for machinery purchases.

b) Frequent break-downs as a result of untrained operators and lack of mechanics with experience in the maintenance and repair procedures of such high horse power tractors. One should be aware of the fact that a break-down in a large tractor equalizes the break-down in 3 or more small tractors. This is perhaps one of the serious disadvantages of utilizing large h.p. tractors.

c) High cost of spare parts as they are not locally available and often ordered from abroad by air freight.

2. Planting equipment, ploughs and harrows shown in tables (6) and (7) are :-

- 37 -
<table>
<thead>
<tr>
<th>Machine</th>
<th>Type and Model</th>
<th>Quant.</th>
<th>Yr Purchased</th>
<th>Operable</th>
<th>Need Repair</th>
<th>Inoperable</th>
</tr>
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<tbody>
<tr>
<td>A. Chalmers - Planter 588351</td>
<td></td>
<td>1</td>
<td>1977/78</td>
<td>1</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Massey Furgson 30 - S</td>
<td>D +</td>
<td>3</td>
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<td>-</td>
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<tr>
<td>Massey Ferguson 80 S. D.</td>
<td></td>
<td>2</td>
<td>&quot;</td>
<td>2</td>
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<tr>
<td>John Shearer Drill</td>
<td></td>
<td>1</td>
<td>&quot;</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bettinson Drill with Fertilizer</td>
<td></td>
<td>1</td>
<td>1978/79</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hestair Stanley - Jumbo Planter</td>
<td></td>
<td>1</td>
<td>&quot;</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Co-Op - 1001 S. D.</td>
<td></td>
<td>4</td>
<td>1980/81</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cock Shutt 234 S. D.</td>
<td></td>
<td>2</td>
<td>&quot;</td>
<td>-</td>
<td>2</td>
<td>-</td>
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<tr>
<td>Co-Op 1001 S. D.</td>
<td></td>
<td>26</td>
<td>&quot;</td>
<td>23</td>
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<tr>
<td>I. H. 234 S. D.</td>
<td></td>
<td>1</td>
<td>1980/81</td>
<td>1</td>
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<td>-</td>
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<tr>
<td>Co-Op 1001 S. D.</td>
<td></td>
<td>7</td>
<td>1981/82</td>
<td>7</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Brand new - not used.
+ S. D. - one way disk harrow with seeder-box.
<table>
<thead>
<tr>
<th>Machine Type and Model</th>
<th>Qty.</th>
<th>Yr. Purchased</th>
<th>Condition Oper.</th>
<th>Condition Need Repair</th>
<th>Condition Inoperable</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Shearer Chisel plow</td>
<td>1</td>
<td>1977/78</td>
<td>-</td>
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<tr>
<td>John Shearer Cultivator</td>
<td>2</td>
<td></td>
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<td>Simba Chiesel plow</td>
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<tr>
<td>M. F. 7390 cultivator</td>
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<td></td>
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<tr>
<td>Allis chalmers cultivator</td>
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<td></td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Towner offset harrow</td>
<td>2</td>
<td></td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Ezze-on offset Harrow</td>
<td>1</td>
<td></td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Simba offset harrow</td>
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<td></td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Bamford chisel</td>
<td>1</td>
<td></td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Ransome disk plow</td>
<td>1</td>
<td></td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Allis chalmers rotary Hoe</td>
<td>1</td>
<td></td>
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<tr>
<td>Ramsone Spike-tooth harrow</td>
<td>1</td>
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<tr>
<td>Gard offset harrow</td>
<td>1</td>
<td>1980/81</td>
<td>-</td>
<td>1</td>
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<tr>
<td>Hesaton-sin harrow</td>
<td>2</td>
<td>1981/82</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>I.H. one way harrow</td>
<td>4</td>
<td>1981/82</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Paramiter offset harrow</td>
<td>4</td>
<td>1981/82</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Brand New – Never Used – Need Tyres.
a) more than needed
b) varied in makes and origin
c) some are un-necessarily ordered, such Allis Chalmers
planter model 588351 and Ransome Disk plough and these have
never been used.
d) Planting equipment such as John Sheaver drill, Bettinson
drill with fertilizer and the Hestair Stanly Jumbo planter
and some tillage equipment makes, John Sheaver, Ezze-on and
Hesston-Sin, have not been introduced to Sudan and thus
operators and mechanics were not familiar with their operation
and repair, a situation that resulted in the following :-

i ) purchase of extremely expensive items.
ii ) frequent break-downs
iii) inefficient utilization of the machine.
iv ) Expensive spare parts purchase. The lack of spare
parts often resulted in the adoption of canabilization.

3. Requirements of some of the most important items are under-estimated.
The earth-moving equipment, shown in Table (9) are minimal; one cater-
pillar D6 tractor and one front loader are by no means adequate to
construct and maintain roads and haffirs in a project of this size.

4. While the technical report did not recommend the purchase of
fertilizer spreader and recommended aerial spraying, the management
consultants purchased one Lely spreader and two Dorman Sprayers.

5. Information presented in Table(12) revealed that the workshop
was poorly equipped and inefficiently managed.

6. Training of operators and workshop staff was the responsibility
of the management consultants, but this objective was not realized.
<table>
<thead>
<tr>
<th>Machine make and Model</th>
<th>Qty.</th>
<th>Yr. Purchased</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Nominator 105 combine</td>
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<td>1978/79</td>
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</tr>
<tr>
<td>Class Nominator 75 combine</td>
<td>3</td>
<td>1980/81</td>
<td>Operable: 3, Need Repair: -, Inoperable: -</td>
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<tr>
<td>John Deere 955 combine</td>
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<td>1980/81</td>
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</tr>
<tr>
<td>Allis Chalmers 860 stripper</td>
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<td>Operable: - , Need Repair: 1, Inoperable: -</td>
</tr>
<tr>
<td>Allis Chalmers 880 stripper</td>
<td>2</td>
<td>1980/81</td>
<td>Operable: 1, Need Repair: -, Inoperable: -</td>
</tr>
<tr>
<td>Allis Chalmers 880 stripper</td>
<td>5</td>
<td>1981/82</td>
<td>Operable: 5, Need Repair: -, Inoperable: -</td>
</tr>
<tr>
<td>Machine</td>
<td>Make and Model</td>
<td>Qty.</td>
<td>Condition</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------</td>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Cat. Motor Grader</td>
<td>12OB</td>
<td>2</td>
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<tr>
<td>Cat. D-6</td>
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<td></td>
</tr>
<tr>
<td>Front Loader</td>
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</tr>
<tr>
<td>Machine type and Make</td>
<td>Quant.</td>
<td>Yr. Purchase</td>
<td>Operable</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------</td>
<td>--------------</td>
<td>----------</td>
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<td>Water Tanks 39000 Gal.</td>
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<td>Water Tank</td>
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<tr>
<td>Trailers marston</td>
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<td>-</td>
</tr>
<tr>
<td>Trailers salop</td>
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<td>1980/81</td>
<td>3</td>
</tr>
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<td>Locally made trailers</td>
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<td>Machine type and Make</td>
<td>Quant.</td>
<td>Yr. Purchase</td>
<td>Condition</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------</td>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>Operable</td>
</tr>
<tr>
<td>Unimoc trucks</td>
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<td>1977/78</td>
<td>1</td>
</tr>
<tr>
<td>Water Pumps with lister engine</td>
<td>6</td>
<td>&quot;</td>
<td>3</td>
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<tr>
<td>Water Pumps with lister engine</td>
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<td>2</td>
</tr>
<tr>
<td>Lely Speader</td>
<td>1</td>
<td>1977/78</td>
<td>-</td>
</tr>
<tr>
<td>Dorman Sprayers</td>
<td>2</td>
<td>1981/82</td>
<td>2</td>
</tr>
<tr>
<td>M. F. 150 Rotary Mowers</td>
<td>4</td>
<td>1981/82</td>
<td>4</td>
</tr>
<tr>
<td>I. H. B23 Cutterbar Mowers</td>
<td>1</td>
<td>1977/78</td>
<td>-</td>
</tr>
<tr>
<td>Eraschieber Blade</td>
<td>1</td>
<td>&quot;</td>
<td>-</td>
</tr>
<tr>
<td>Dorman Sprayers</td>
<td>2</td>
<td>&quot;</td>
<td>-</td>
</tr>
<tr>
<td>Lister elevator</td>
<td>1</td>
<td>&quot;</td>
<td>-</td>
</tr>
<tr>
<td>Rollers</td>
<td>5</td>
<td>&quot;</td>
<td>-</td>
</tr>
<tr>
<td>Amazon Spreader (10 tons)</td>
<td>4</td>
<td>1980/81</td>
<td>4</td>
</tr>
<tr>
<td>Caldwell (180) Slasher</td>
<td>1</td>
<td>1977/78</td>
<td>1</td>
</tr>
<tr>
<td>Equipment</td>
<td>Qty.</td>
<td>Operable</td>
<td>Need Repair</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>------</td>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>Portable Petrow welding machine</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Portable Zetor welding machine</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Stationary small welding machines</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Battery charger</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Ursus tire repair unit (Tractors)</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tire repair unit (small)</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Air compressors</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Stationary press drill</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Electric hack saw</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Portable grinder</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Portable crane</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Electric hand drill</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Oxy-acetylene unit</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Bench vices</td>
<td>5</td>
<td>5</td>
<td>-</td>
</tr>
</tbody>
</table>
More details regarding training aspects are discussed in chapter VI of this report.

7. The management consultants did not leave behind any records of the performance test carried-out during the pilot stage.

8. Some of the equipment purchased were inefficient to operate such as the Meston harrow. Unlike the COOP or Massy Ferguson one-way disk harrow with seeder-box the Meston needs to be raised before attempting a turn at the end of the field. This procedure increases the idle time spent in turning thus reducing the field efficiency of the machine.

9. The consultants purchased some equipment with no parts catalogue and no covering device as in the case of M. F. 30 wide level disk with seeder box. This resulted in the purchase of additional equipment such as the 5 rollers trailed behind the machine and used as covering device. The 5 rollers are now out of order.

4 - 2 EXISTING FARM MECHANIZATION PROGRAMME:

After the management consultants contract was terminated in 1979, a Sudanese team took over just before the beginning of the 1980/81 season. In the following paragraphs the situation regarding tractors and other farm implements, mechanical agricultural operations carried-out, workshop facilities and staffing will be discussed. Some recommendations concerning management aspects of farm machines will then be outlined.

4.2.1. Tractors and Implements:

As shown in table (14), additional four tractors with over 220 h.p., four tractors with 150 h.p. and 25 tractors in the range of 70 - 90 h.p.
**TABLE (13) DISTRIBUTION OF EQUIPMENT IN THE THREE SECTIONS OF THE PROJECT**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Section I</th>
<th>Section II</th>
<th>Section III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Camp II</td>
<td>Camp III</td>
<td>Camp Iahag</td>
</tr>
<tr>
<td>I.H. one way harrow</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Amazon Spreader</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coop 1001 (24 disks)</td>
<td>9</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Caldwell (18) slasher</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Parameter harrow</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MF (30) disk with drill</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Towner offset harrow</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Lister elevator</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Slap trailer</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Locally made trailer</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Hesston-harrow</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>John shearer cultivator</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marston trailer</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>I.H. 234 S.D.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MF (80) disk with drill</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lely spreader</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>John shearer plow</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Egze- on harrow</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Class dominator combine</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>John deere 955 combine</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Class mercator combine</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Job description</td>
<td>Qualification</td>
<td>Training</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>Workshop engineer</td>
<td>B.Sc. Mechanization</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Assistant Engineer</td>
<td>Tech. High School Cent.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Technician (Electrician)</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Technician (Mechanic)</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Head Mechanic</td>
<td>Experience</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Mechanic</td>
<td>Experience</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Asst. Mechanics</td>
<td>Experience</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Electricians</td>
<td>&quot;</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Asst. Electrician</td>
<td>&quot;</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Blacksmith</td>
<td>&quot;</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Asst. Blacksmith</td>
<td>&quot;</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Tin Smith</td>
<td>&quot;</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Greasers</td>
<td>&quot;</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Permanent Tractor Operator</td>
<td>&quot;</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

No. Numbers %
1 5 100
8 2 25
were purchased during the past two seasons. Out of the 29 tractors, 20 (70%) are in good working condition, 8 (28%) need repair and only one tractor (2%) namely Ebro is inoperable. The percentage of tractors that need repair is considered to be, to some extent, high. This is due solely to factors such as:

a - Untrained tractor operators
b - Lack of workshop facilities
c - Untrained mechanics and other workshop staff

Twenty five new tractors, namely Ford, will be purchased this season 1983/84. This will increase the total tractor fleet number to 56 operable tractors (31 + 25), plus 7 tractors that should be repaired for the 1983/84 season. The total area that will be put under production for the 1983/84 season is estimated to be 52,000 feddans.

The information presented in table (6) reveals that out of the 49 planting equipment, 41 (83%) are in operable condition, 5 (10%) need repair and only 3 (7%) are in inoperable conditions. The situation regarding primary and secondary tillage equipment, harvesting equipment tractors and other miscellaneous equipment is presented in tables 7, 8, 10 and 11 respectively.

4.2.2. Workshop Facilities and Staffing:

The main central workshop consists of a 45 mx20m building which is open in front to allow for entrance of tractors and implements for repairs. The workshop, as shown in Table (12) is considered to be poorly equipped. The equipments available are old and unreliable and will only do minimal minor repairs and for a limited number of machines. From Table (14) it is clear that most of the personnel received no prior training. Out of the 45 workshop staff only 10 (22%) received
short training courses either abroad or in the country. Since the workshop is considered to be the heart of a project that relies entirely upon machines for agricultural production, the following recommendations should be given the highest priority and funds should be readily made available for this purpose.

1. An intensive inservice training for all workshop staff should be administered.

2. Since the project is located in a remote area the following workshop equipment should be purchased.
   a) Two complete engine overhaul tools and equipment.
   b) Four tire repair units for large and small tires.
   c) Fuel pump and automizer testing and repair units.
   d) Two complete electric stations.
   e) One lathe.
   f) One milling machine.
   g) Mechanic workshop tools (to be specified)
      - complete blacksmith station
      - complete tin-smith station
      - carpentry electric and hand tools.

3. Workshop floor should be cleaned and paved.

4. Gasolene and diesel fuel pump stations should be constructed for storage of fuel and filling up tractors and other machines. It was noticed that the consumption of fuel filters is very high because diesel fuel is stored in barrels. Barrels as is well known are uneconomic to use, difficult to transport, and they do accumulate dirt and water and increase losses. Tractors were reported to stop frequently during critical working conditions because of dirty fuel or fuel mixed with water.
5. It was observed that approximately 7 gallons in every barrel of oil are lost because no hand pump is used to pump oil out the barrel. Therefore, it is recommended that 2 hand pumps be purchased for this purpose.

6. More than one man for tire repair is needed. At least one tire repair unit should be purchased immediately.

7. It is recommended that another well-equipped workshop, be constructed for the maintenance and repair of vehicles. The existing workshop should be extended to accommodate trucks.

8. The existing store for the spare parts (8 m x 20 m) should be run properly using the card system. Fast moving parts should be ordered and stored.

9. Because of the unavailability of well trained mechanical engineers and mechanics it is worth considering hiring expatriates, on contract basis, for managing the workshop and performing major repairs.

4.3. AGRICULTURAL OPERATIONS AND MACHINE PERFORMANCE :

4.3.1. Land Preparation :

Land preparation practices are the same for all crops grown—these comprise primary land preparation, using heavy and large disk blades to insure deep penetration and greater pulverization, followed by secondary operations, using lighter disks with smaller disk blade diameter for clod crushing and for the formation of fine seedbed. Traditionally, in mechanized farming only one machine, the wide level disk with seeder-box, is used to perform both primary and secondary operations, in this respect, one should stress the need for more work concerning the following aspects:

- 51 -
a) Larger disks require larger expensive and sophisticated tractors which means greater fuel consumption; an economic comparative analysis is, therefore, needed.

b) Availability of well trained operators and mechanics should be investigated.

c) Availability and cost of spare parts should be surveyed.

d) Effect of machines on soil conservation measures, yields obtained and soil texture and permeability should be thoroughly investigated.

4.3.1.1. Primary Land Preparation:

4.3.1.1.1. New Land:

Primary land preparation operations start after the first showers and the emergence of weeds to a height of about 1-3 inches. The following machines are usually utilized to perform this operation.

- Towner offset disk harrow drawn by Versatile 330 h.p. tractor or the Allis Chalmers and Versatile 250 h.p. tractors. The field capacity of this disk was roughly calculated to be 9-10 feddans/hr. It proved efficient when used in land heavily infested with weeds, or land with sharp depressions caused by the removal of tree stumps or where there is a compression of top soil caused by animal path. The available towner disks are inadequate.

- The COOP wide level disk with seeder-box triple hitched is used in relatively clean land with no depressions. The field capacity of the triple hitched COOP disk was calculated to be 7-8 F/hr.

- IH one way disk harrow is sometimes used when hitched to the
Allis chalmers 7045 (150 h.p.) tractors. It proved to be satisfactory in cotton stalks incorporation but the number available, only (4), is not adequate.

The one-way Hesston disk which is drawn by a 250 h.p. tractor is sometimes used to perform this operation. However, the field capacity of this machine tends to decrease because it should be raised when attempting end of the field turns.

4.3.1.1.2 Previously Cultivated Land:

The wide level disk with seeder-box is often used to perform this operation.

4.3.1.2 Secondary Land Preparation:

Wide level disks with seeder-box, double or tripble hitched are utilized to perform this operation after the second germination of weeds. When disks are double hitched, a 150 h.p. tractor could be used and when tripble hitched a tractor 250 h.p. or more is usually used, to draw implements.

4.3.2 Sowing:

4.3.2.1 Sorghum:

Wide level disks with seeder-box are utilized to perform sorghum sowing and they are usually double or tripble hitched. Technically no problem is facing the field staff in performing this operation. However—due to the limited number of machinery available to them the sowing period is extended beyond reasonable limits, to mid-September in the season 1982/83.

4.3.2.2 Sesame:

M. F. 80 and M. F. 30 wide level disks with seeder-box are used for sowing sesame. As the M. F. 30 disk has no covering devices,
the COOP disk is then used to cover the sesame seeds. When M. F. 80 is used the tubes get filled with mud and the seeds get placed only 3 inches deep. This results in poor seedling emergence. Sometimes, labourers broadcast the seeds while striding the top of the seeder-box and in this case also the seeds are covered by the COOP disk.

Sowing and covering of seeds should be completed in one operation. The procedure followed increases the cost of production.

Manual broadcasting of sesame seeds while labourers are sitting on the top of the machine is hazardous. Many accidents have occurred specially during the night shifts.

- Supervision to insure that labourers are actually broadcasting is essential.

- Hand broadcasting often results in non uniform seed rates.

4.3.2.3. **Cotton**:

Broadcasting is the only method used for sowing cotton in the project. It is performed either manually as with sesame or by the machine using the 4 Amazon fertilizer spreaders. Seed covering is done by the COOP disk as with sesame.

However, the utilization of the Amazon spreader raises a number of issues:

1. P.T.O. shaft coupling pin breaks frequently and causes severe delays. This frequent breakage might be due either to the unsynchronized speeds of the P.T.O. shaft and spreader distribution shaft or to the non-alignment of the P.T.O. shaft with the height of the spreader.
2. Lines 10 to 20 metres apart should be marked on the field.

3. Overlapping usually occurs because operators do not drive along straight lines.

Needless to say that broadcasting does not allow mechanical weeding and cotton picking. It was noticed that cotton planters are not used.

To use cotton planters, the seeds have to be acid delinted which is hard to find locally. On the other hand the performance of mechanical delinters was found to be unsatisfactory to the field personnel.

4.3.3. **Weed and Pest Control**

Suitable herbicides are applied by air planes on sorghum and cotton fields, usually after sowing and before germination, in addition to two or three supporting hand weedicings. In the case of cotton some 4 sprayings are performed to combat flee beetle, the American bollworm and the thrips.

4.3.4. **Fertilization**

Only applied for cotton grown in old land using the Amazon fertilizer spreader. Cotton grown in new land receives no fertilizer.

4.3.5. **Harvesting**

4.3.5.1. **Sorghum**

Despite the fact that six combine harvesters were purchased, sorghum heads are cut manually and the combine is used for threshing. Only about 4,000 out of the 32,000 feddans grown with sorghum were mechanically harvested. Lodging of sorghum plants was quoted as the
main reason for not using the combine. As most of the sorghum was grown late in the season it was subjected to water stress and hence to stem borers and the occurrence of the char-cow rot which causes lodging.

4.3.5.2. Cotton:

Despite the presence of eight Allis Chalmers strippers, all cotton was picked manually from the 4,000 feddans which were grown with the crop this season (82/83).

Interviews conducted revealed that strippers were not used for the following:–

a – Losses were found to be too high (15 – 35%).

b – Percent of trash is also too high (20%) this necessitates seed cotton pre-cleaning before feeding it to the ginnaries but pre-cleaners are not available at Damazin ginnary.

c – Cotton was not grown in rows.

4.3.5.3. Sesame:

Sesame harvest is carried-out manually. Some trials were made to use a modified Class combine header – but it did not prove effective.

4.4. GENERAL RECOMMENDATIONS:

1) All tractors and machines both at the main camp and at the section camps are kept under the sun. Apparently, there is need for machine sheds to protect them and elongate their working life.

2) Distribution of machines among the camps should be reconsidered according to the following factors:–

- 56 -
a) Crops to be grown.
b) Area to be cultivated.
c) Distance from the main workshop.

4) The number of trailers should be increased. It was noticed that combine harvesters are sometimes used to transport harvested crops from the field to the collection camp.

5) Temporary camps for operators should be constructed close to the field to reduce time losses due to the journeys they make to the main field camp to have meals.

6) A strict maintenance system should be established and a much higher level of maintenance should be performed.

7) The wide range of models and makes in the project complicates the procurment of spare parts and the maintenance of the implements and tractors. It is thus recommended that makes and models be unified as far as possible.

8) The company should offer higher wages inorder to attract more experienced tractor operators and mechanics.

9) Since the company enjoys financial flexibility, fast moving parts, fuel, oil and lubricants should be secured to keep delays and down-time to a minimum.

10) A more selective and meticulous method of purchase of tractors and implements should be considered.

11) More effective supervision on all parties involved, specially operators and mechanics should be maintained.
12) It is recommended that the following organization for management of tractors and machinery be considered;

a) An agricultural engineering department should be created and headed by an engineer responsible to the site project manager.
   - The head of the agricultural engineering department should be assisted by:
   - a maintenance mechanical engineer who will be responsible for managing the tractors, machinery and implements, the trucks, the agricultural machinery workshop and the motor vehicle workshop. Each of these two maintenance workshops should be headed by a workshop superintendent.

b) An operation agricultural engineer who will be responsible for performing all field operations, maintenance of roads and haffirs and operations of electricity and water plants, in addition to the maintenance of buildings. He will be assisted by an assistant engineer or an experienced graduate of the higher institute of agriculture.

c) A head store-keeper who shall be responsible for management of orders, and supplies to the workshop stores and to the main store.

4.5. RECOMMENDATIONS REGARDING MECHANICAL AGRICULTURAL OPERATIONS:

1. It is highly recommended that all tractors and machines be ready before the season and that a stock of spare parts be available to insure commencement of agricultural operations, specially sowing, in time. In case of sorghum this will insure mechanical harvesting.

2. Additional equipment, as required, should be purchased.
3. Seed drills with fluted wheel feeding devices proved to be successful for sowing sesame, therefore, the purchase of some is recommended: When sowing sesame failure to germinate or failure of seedlings to emerge often result from factors such as:

a - Rough seed-bed that results from the use of cultivators as secondary operation implement.

b - Absence of secondary operation with disk machine.

c - Improper sowing depth.

d - Uncovered seeds.

4. Mechanical delinting and planting of cotton with cotton planters proved to be successful and they are highly recommended for adoption. Planters with fertilizer hoppers could be used.

5. When cotton is mechanically planted in time according to the recommended spacing, strippers can be successfully used for picking. However operators should be properly trained to use them.

6. When the sowing of both sesame and cotton is carried-out mechanically, the supporting weedings can be performed mechanically using high clearance tractors.

7. The University of California at River side designed a combine harvester header for harvesting sesame.

A prototype is available at Abu Naama'a Research Station and has proved to be effective. It is recommended that a similar header be ordered and tried out in the next season.

8. An intensive training for all permanent tractor operators should be administered.
Results of the research work carried-out at Tozi Research Farm in the late 50's and the experiments performed by the Canadian mechanization team conducted at both Agadi and Semeen state farms during 1978 - 80 revealed that post-harvest tillage operation decreases water loss during the dry season and contributes to early sowing.
CHAPTER V

MARKETING ARRANGEMENTS
CHAPTER V

5. MARKETING ARRANGEMENTS

5.1. CASH CROPS GROWN

During the pilot stage numerous crops were tried, including cotton, sesame, sorghum, sunflower, soyabean, etc. However, the recommendation of the consultants who managed the pilot stage was to confine commercial production to two cash crops viz cotton and sesame. It was concluded that the production of sorghum is not economically viable at the current prices of 1978, while the other crops tried needed further experimental work to assess their viability. It was assumed that cotton production can be completely mechanized and the scarcity of labour during harvest time shall not constitute a limiting factor. The local varieties of sesame were replaced with the variety Mabral from Venezuela which was believed to be wholly mechanized; thus overcoming the shattering hazard of the local variety. In practice all these assumptions proved to be wrong.

Although the mechanization of cotton was technically established and the necessary equipments were procured, the management was discouraged to mechanize cotton picking, the main area where mechanization was mostly needed. It was discovered that the newly erected ginning factory at Damazin is not equipped with pre-cleaners which separate the trash from the seed cotton before ginning. As a result the management had to transport the whole product of seed cotton of 1981 to El Fau ginning factories in the Eastern Region (about 500 kms) for ginning, and thereby incur an incremental cost.

This was cited as the main reason why the cotton area was reduced from 10000 feds in 1981/82 to 4000 feds in 1982/83. All
the production of cotton was completely hand-picked. For the same reason, the area planned to be cultivated with cotton next season (1983/84) shall be confined to a maximum of 5000 feds so that the whole crop can easily be hand-picked. If by next season the authorities were not able to equip the Damazin Factory with the crucial pre-cleaners the management of DAAPCO shall procure them and clear the way for the expansion of mechanized cotton picking.

The problems with sesame were more complicated. As sesame is grown at the beginning of the rainy season, late June or early July, it has to be weeded during August, when the rains are the heaviest, and the mechanical operations in the field are reduced to the minimum. On the other hand, the roads get closed and cannot possibly be utilized to transport casual labour for weeding. As sesame is very much susceptible to weeds, the cultivable area should be tailored to the capacity of manual weeding. During the past three seasons a number of herbicides

Therefore, unless a suitable herbicide is being selected, the area under sesame shall not be greatly expanded.

The variety Mabral which was assumed to be the most suited for mechanical harvesting proved to be highly susceptible to the webworm and the bollworm under Sudan conditions and was excluded from the rotation. The varieties currently grown are shattering and therefore the expansion of the area under sesame has to be confined to the availability of casual labour at the crucial harvest time.

It is for all these reasons that the area under sesame shall be confined to a maximum of 2000 acres.

All agricultural operations for sorghum production can be completely mechanized including the utilization of herbicides to eradicate the weeds and the harvesting of the crop. The main problem
with sorghum was its market price. However, thanks to the subsidy policy of the Kingdom of Saudi Arabia which encourages the importation of sorghum as a feed, the local average price has increased from LS. 34 in 1979 to LS. 300 in 1980. This has dramatically changed the economics of dura and made it a highly competitive crop. As a result of this and due to the problems encountered with production of the other crops most of the developed area has been devoted to sorghum. It is now occupying 87.5% of the developed area and according to the plan set for next year it shall occupy 87% of the cropped area. This pattern of cropping should not continue and in no way should the area under sorghum exceed 50% of the cropped land as has been mentioned in Chapter III.

Sunflower is one of the promising crops which has successfully been tried in the scheme area. However, as there is no internal market for it yet, the whole product of the experimental plot in the season 1981/82 was fed to the livestock. In fact there are a number of promoters of sunflower oil in the Sudan who have processed the oil and did create a limited market for it. The management was advised to contact those promoters and conclude an agreement with them. If these effort prove to be successful new horizons for development shall be opened for the scheme.

The cultivation of the other crops shall be confined to the experimental plots until all the technical aspects of agricultural operations have been resolved. Till then, the crops which shall be included in the rotation shall be confined to cotton, sesame and sorghum.

5.2. MARKETING CHANNELS:

The Agreement of establishment offers DAAPCO the privilege to create its own marketing channels and the right to sell internally
and in the export markets. However, due to the newness of the
scheme and the limited area developed so far DAAPCO was inclined
to utilize the existing channels.

5.2.1. Marketing Channels for Cotton

Cotton marketing in the Sudan is monopolized by a government
agency, the Cotton Marketing Corporation (CMC) with its four
subsidiary companies. CMC undertakes responsibility to promote and
sell all the lint in the international market at the highest avail-
able prices against a fee which may come up to .6% of the export price
FOB Port Sudan. However, since last year the management commissioned
a consulting firm to shop for the highest bidder for the Damazin
cotton in the international market for a fee of only 2% of the FOB
price. As a result the management got the highest price offered to
any comparable varieties against a minimal fee. However, this
independence of CMC may deprive DAAPCO of some of the facilities
offered by CMC such as the stores in Port Sudan (see Section 5.3).

5.2.2. Marketing Channels for Sesame

There is a government agency, Sudan Oil Seed Company, which
used to monopolize the export of all oil seeds and vegetable oils
against a fee. However, since 1980, the monopoly was broken down
and the export trade was opened to all. Apart from this there is a
wide internal market, as sesame is one of the major oils consumed
in the Sudan.

As the quantities of sesame produced in the scheme are still
limited, they have all been sold ex-farm gate and to wholesalers.
Sesame is usually harvested in the month of October and can easily
be kept in the farm till the following month of April. This provides
the management with ample time to negotiate reasonable ex-farm gate
prices. As no expansion in the area of sesame is envisaged in the

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near future the present selling practices are thought to be adequate and should be pursued.

5.2.3. Marketing Channels for Sorghum

Sorghum is the main staple food in the country, and is readily marketed all over the year. In the various production areas there are organized wholesale markets where the bulk of the produce is transacted.

Since 1979 a limited export market for sorghum has been developing in Saudi Arabia and the Government policy is to encourage all interested parties to indulge in the export trade. The management of the scheme has utilized the opportunity to export in the season 1981/82 some 3000 tons at the lucrative price of US$ 300.- a ton CIF Jeddah. In the current season more than three thousand tons were transported to Port Sudan as a first step for their export to Saudi Arabia when it was discovered that the declared price in Saudi Arabia is less than the local market price.

Apart from the consignment which was exported all other production is being sold ex-farm gate. Usually a limited number of wholesalers are requested to bid for specific quantities at the farm. If the traders do not have their own transport facilities then DAAPCO utilizes its trucking fleet to deliver the consignment at the current market rates.

Sorghum is usually harvested during the months of January to April and all the produce has to be transported from the farm before the onset of the rainy season in June. During these months the prices are usually at their lowest. Then the tendency for the prices is to increase till the next harvest season. In order to make use of these prices DAAPCO shall have to acquire its own storage
facilities where they may be accessible all the year round.

5.3. STORAGE FACILITIES

At present DAAPCO has only one store 40 x 20 m$^2$ at the scheme's headquarters and it is being utilized for storing almost everything from food items (sorghum) to spare parts, to seeds, chemicals and fertilizers. However, there is need to compartmentalize the store so that the different items can be properly stored. In addition to the store a number of containers are also utilized as stores. For temporary storage in the various units of the scheme huts of local material are also used to store the necessary items. As all field crops are kept in the field before being transported to their destination, the storage facilities at the scheme's H. Q. are adequate and need not be augmented at present. However, as all roads are closed during the rainy season and transport virtually stops, the field crops need to be stored outside the scheme area where they can be accessible.

5.3.1. Storage Facilities for Cotton

Cotton is the number one cash crop which can be easily exported and provide the scheme with foreign currency. As such all the lint has to be stored in Port Sudan where it can be easily shipped, when, and if, the international price is suitable. At present DAAPCO utilizes the storage facilities of the Cotton Marketing Corporation, but these facilities may not be available if DAAPCO continues to export their own lint without the help of the Corporation. On the other hand it is generally believed that the storage facilities of the private sector are inadequate and inefficient. All this necessitates that DAAPCO should have their own stores.

Export of cotton cake is prohibited by law and therefore all
cotton cake has to be sold ex-ginning factory at Damazin or stored nearby where it can be accessible all the time.

5.3.2. **Storage Facilities for Dura and Sesame**

There is a wide market for sorghum internally and a limited export market in Saudi Arabia. In the circumstances, there is need for storage facilities nearby the scheme area as well as in Port Sudan. In the absence of storage facilities and due to the on-set of the rainy season, the management is encouraged to sell the crop exfarm gate immediately after harvest, when the dura prices at the local market are at their lowest. However, in order to make use of the higher prices later in the season, the sorghum has to be stored outside the scheme area where it can be easily accessible.

The nearest town to the scheme area is Damazin town, some 90 km to the south-east. Originally, Damazin was planned to be connected with the national highway networks, but for various reasons, the work on the highway was discontinued at Singa town, some 150 kms from the scheme’s H. Q. As it is not known when the work on the highway shall be resumed Singa town should be selected as the site of the stores. Moreover, Singa lies on the way between the scheme and Port Sudan and in this respect it is even better situated than Damazin. In addition to this Singa is a large town and its situation near the centre of the mechanized rainfed area in the Central Region has facilitated its development as an important market for agricultural crops.

Apart from the local market part of the sorghum may be exported to Saudi Arabia in which case there is need for storage facilities in Port Sudan.

* The market prospects for sesame internally and externally are wide open.
It is difficult at this stage to estimate the ultimate storage capacity required in both Port Sudan and Singa. However, if a cropping pattern along the lines suggested in Chapter Three is to be adopted and if the area is to be expanded to the full capacity of the first phase (70,000 acres) then there is need for a storage capacity of 40,000 cubic meters in Singa and 30,000 cubic meters in Port Sudan.

5.4. TRANSPORT FACILITIES

The remoteness of the scheme and the absence of transport facilities may have been the main reasons behind the proposal in the original feasibility study that all sales be concluded at farm-gate. This was not realistic, at least in the case of cotton, which has to be transported to the ginning factories at Damazin. Moreover, selling at farm-gate does not resolve the problem of transport and may refer it to the buyers who shall be influenced by the transport cost in dictating their prices. In the review of the feasibility study the problem was duly appreciated to the effect that a fleet of 26 transport trucks was included in the revised investment costs of the project. Of this fleet only 5 trucks and 12 lorries have been acquired. The lorries are mainly for the internal transport of water, labourers, etc. and they can hardly be utilized for crop transport.

As all the crops have to be transported from the field before mid-June there is a span of three to four months during which all the crops have to be transported to Damazin and Singa and later to Port Sudan.

If the cropping pattern outlined in Chapter III is to be adopted then the volume of crops to be transported may be estimated at 9 thousand tons of seed cotton, 25 thousand tons of sorghum and 1.1
thousand tons of sesame. Accordingly there is need for 25 trucks (50 tons), 10 for the transport of cotton and 15 for the transport of both sorghum and sesame.

5.5. MARKETING UNIT

In the original study a commercial department was envisaged to take care of all marketing activities (see Chapter VI). However, during the pilot stage the foreign management developed a limited area and the question of marketing did not pose seriously.

The scheme then embarked on the commercial phase gradually without creating additional units. On the other hand the management was faced with a number of technical problems concerning the production of the proposed cash crops that the urgency of creating a marketing unit has never occurred.

The current administrative set-up does not include a marketing specialist or even a general economist and all marketing decisions are taken by the Director-General and approved by the board of directors. The Director-General is being assisted in this respect by an accountant. The marketing process is usually effected through open or closed tenders.

If this sort of arrangement was thought to be adequate in the past, due to the limited area being cropped and the dominance of sorghum in the rotation, with the expansion of the area and in order to gear the cropping pattern to the market tendencies a new arrangement has to be devised. Proof for the need for a man to follow closely the developments in the various markets was given this year. Full three thousand tons of sorghum were transported to Port Sudan when it was discovered that the declared price in Saudi Arabia was not remunerative and all the sorghum was to be
re-transported to Central Sudan at an additional cost of LS. 55.-
a ton.

In the circumstances a marketing specialist with a fair
experience need to be incorporated in the management to advise the
Director-General on the marketing aspects, and assist him in
performing his duties. In future when the area is duly expanded
and the crops diversified the marketing specialist should be assisted
CHAPTER VI

6. ORGANIZATION AND MANAGEMENT

The Organization and management aspects of the scheme have been evaluated according to the following concept.

Management is an activity whereby a cohesive and controlled team of people would, with and through others, see to it that the objectives of the enterprise are achieved with the least possible cost. In other words, the management team is responsible for the efficient and effective handling of the human and physical resources of the enterprise so as to achieve the objectives economically.

As such, the management and organizational set-up of any enterprise should not only stem-up from the objectives of the enterprise but should also reflect them.

Therefore, and as it will be shown below, the drastic changes which were made in the original objectives, first by Dalgaty Agricultural Development International Limited and secondly, by the current Sudanese management led to sharp changes in the management and organizational set-up. This process - of forceful changes in objectives and the resulting changes in management and organizational structure - has been reinforced by a strong reversed process wherein the changes in management led to still more changes in the objectives. It seems to us that this two-way process is still on-going. Needless to say that this situation is not conducive neither to the stability of the scheme nor to the accomplishment of its objectives.
6.1. **ORIGINAL STUDY : SUDANESE CONSULTANT'S TECHNICAL REPORT**

**ORGANIZATION AND MANAGEMENT**

6.1.1. **General Structure**

It was proposed that the organizational and management structure of the Project should consist of the following :-

(a) A Board of Directors, a Managing Director, a Production Manager, and six functional units including :-
   - a crop production department
   - an animal production department
   - a commercial department
   - a finance and accounting department
   - a service and supplies department
   - a personnel department.

(See Chart 1)

6.1.2. **The Board of Directors**

It shall be the highest governing body of the project. Its main duties shall be the formulation of project policies and the establishment of short and long term strategies. It is expected that it will be composed of the major shareholders.

6.1.3. **The Managing Director**

He shall be the highest executive officer. His major duty shall be the transformation of the Board of Director's policy guidelines into programmes of action. He will also be responsible for securing high project efficiency, that is, producing high returns at a minimum cost.
It was proposed that the General Manager should have the help of the following individuals and departments in order to help him discharge his duties most efficiently:

(a) A Production Manager;
(b) Six main departments; and
(c) Four auxiliary departments (i.e. internal auditing, public relations, planning and development and a legal department).

(See Chart 1)

6.1.4. The Production Manager

He shall be the field representative of the Managing Director. He will be charged with supervising and coordinating the various project activities on a day-to-day basis. He will also coordinate the functioning of the six main departments.

6.1.5. Crop Production Department

This department shall be concerned with all farming activities in the project. It shall be headed by a Crop Production Manager, who shall be assisted by the twenty Production Unit Managers, ten Agricultural Engineers, ten Veterinary Officers and other supporting staff.

6.1.6. Animal Production Department

This department shall be charged with the project fattening and breeding activities. The manager of the department shall be assisted by two specialists:

(1) an animal production specialist who shall be responsible
for the functioning of the feed lots and who shall be assisted by four feed-lot managers and supporting staff;

(ii) A Fodder Specialist who shall be responsible for the range management with the help of supporting staff.

6.1.7. Commercial Department

The activities of this department shall include marketing (market research, advertising and sales promotion), distribution and purchases. The Commercial Manager shall be assisted by four submanagers, i.e. by a market research manager, a marketing services manager, a distribution manager and a purchase manager as well as other supporting staff.

6.1.8. Finance and Accounting Department

This department shall monitor and control the cash inflow and outflow of the project. It shall be divided into six main sections: planning and budgeting, credit and collection, payments, banking, investment and cost, and stock. The department shall be headed by a Finance and Accounting Manager who shall be aided by six-sub departmental managers and supporting personnel.

6.1.9. Supplies and Services

This department shall be responsible for power supply: electricity, fuel, etc. and the water supply beside engineering and other services. It shall also provide the required storage facilities. The supply and services Manager shall head the department and be supported by a civil engineer, a mechanical engineer, three regional workshop superintendents, a stores and supplies manager and by a number of technicians and storekeepers.
6.1.10. **Personnel Department**

This department shall be responsible for staff members (from the moment of their application for employment until retirement). The functions of the department shall include the processing of application forms, settlement of disputes, provision of welfare services and a host of other activities which deal with the human capital aspect of the project. The Personnel Manager shall be assisted by four managers: a social services manager; a training manager; a salaries and wages manager; and an industrial relations manager plus other supporting staff.

6.1.11. **Final Comments**

The Sudanese Consultants felt that this was only a broad survey of the proposed management structure of the project. They also proposed that a detailed plan of the duties, the authority relationships and the responsibilities of each unit within the project need to be worked out at a later stage. They maintained that only then can the problems of qualifications of personnel, coordination of activities and vertical and horizontal communication be approached.
CHART 1: The Organizational Structure as Proposed by the Sudanese Consultants in the Original Study

Board of Directors

Public Relations
Internal Auditing

General Manager

Planning & Development
Legal Dept.

Production Manager

Crop Production
Animal Production
Commercial Department
Finance & Accounting
Supplies & Services
Personnel
6.2. MANAGEMENT OF THE PILOT FARM

MEFCA hypothesized that "the larger the management team and the more the development pressure, the greater the risk to the investors that mistakes will occur through management problems. This problem is amplified for Damazin by the need to develop a number of new skills through labour training."

Moreover, MEFCA believed that "the success of the project and from the point of view of investors and lenders, it will be essential that management has the depth and experience and, preferably, the financial commitment to the project to reduce the risk of project failure through inadequate management. In effect, this means that the management of the project must come from an established, sizeable organization with a track-record in agricultural and livestock production. In the Sudan, the only such organization is the Government. For a private sector sponsored project such as this, it is, therefore, necessary to look outside the Sudan, for a management organization to become involved in the project."

As a result of these assumptions, MEFCA, firstly, suggested that Damazin was to be managed, during a pilot stage, by a foreign company — namely, Dalgety — and secondly, to approve of the agreement between Dalgety and Damazin Board of Directors. However, MEFCA felt that the organizational structure proposed in the technical study was reasonable aside from the fact that the technical study made the preliminary proposal that individuals should be separately hired whereas MEFCA'S position is that management should be cohesive and coordinated team.

MEFCA was the Financial Consultant to Prince Mohammed El Faisal
MEFCA also believed that the management contract with Dalgety will be an important factor both in assuring the success of the project and in attracting the participation of foreign financial institutions.

MEFCA proposed that the agreement with Dalgety should apply specifically to the implementation and management of the first phase programme.

The agreement with Dalgety gave it the following responsibilities:

1) the day-to-day management of the first phase;
2) the procurement of both capital items and raw materials;
   and
3) the distribution, shipping and marketing of the products.

The management specified that for carrying out these three responsibilities they will get: a procurement fee, a management fee, a marketing fee – all amounting to US $6 million during the first phase.

In this section we will be concerned mainly with the first of these three responsibilities. Somewhere else in this report the other two responsibilities will be catered for. However, it can be said, at this point, that Dalgety used the agreement with respect to the latter two responsibilities more to its advantage than to the advantage of the investor.

As far as the day-to-day management, the agreement further specified that Damazin Company would control the project: firstly, by limiting the extent of Dalgety's financial authority and through
reporting procedures agreed between Dalegty and the Board. Secondly, that the key role in management would be played by the representative appointed by the Board with whom Dalegty would have a continuous reporting and consultation relationship. This representative would effectively be responsible for ensuring that the project management was properly conducted in line with the policies agreed upon by the shareholders.

The agreement between the Board and Dalegty specified that Dalegty will provide five key management personnel and back-up for the day-to-day management of the project. These staff members are:

- Project Manager
- Administration Manager
- Livestock Supervisor
- Farm Supervisor
- Project Development Foreman
- Workshop Supervisor

As such the management and organizational structure during Dalegty's era can be depicted as in Chart III.

6.3. ASSESSMENT OF DALEGTY'S MANAGEMENT

6.3.1. Depth and Experience:

Dalegty was called in because, supposedly, it has depth and experience in the area of agricultural and livestock production. The information we have indicates that the calibre of Dalegty's personnel who permanently or temporarily worked in the project was rather poor. Considering that a foreign management was originally proposed because a project requires a high degree of research and a high level of agronomic control we believe that
the calibre of personnel brought in by Dalegty was inappropriate. It is worth mentioning that Dalegty always marvelled during its management of the scheme that its personnel are 'doers' rather than 'academically-qualified'.

As far as experience is concerned, two points can be mentioned:

a) that the Sudan has a long (over thirty-five years), wide and rich experience in the field of agricultural research, technical innovations in mechanized farming. It is worth mentioning that the research efforts and findings of TOZI and later Abu Naama Dry Farming Station (established 1951) and Um Benien Livestock Research Centre constitute a very solid base for expansion and development of all types of agricultural technology and advanced development of livestock.

In addition to these two research stations which are located in the same region as is DAAPCO - the Government has big agricultural estates for the last ten years or more.

All of these indicate that DAAPCO's management could have been easily drawn from this reservoir of Government experience. The Government has been helping private as well as joint-venture projects with personnel as well as research findings.

b) The above point coupled with Dalegty's obvious lack of experience in tropical agricultural and livestock production have led to many drastic changes in the original production objectives (see Chapter III) as well as to
the completely unjustified financial commitments (See Chapter IV).

6.3.2. The Financial Commitments of Dalegty:

Unfortunately, Dalegty failed to commit itself financially to the project either because it has made its financial participation practically impossible or because it was not allowed to stay long enough to commit itself.

6.3.3. Manpower Training:

It should be restated that Dalegty was also called-in "to develop a number of new skills through labour training".

We can categorically say that Dalegty failed to provide training for the Sudanese staff whether in the fields of agricultural operations; livestock production or machinery maintenance and repair (workshop and agricultural equipment). As such the project remained, all this time, relying on skills (managerial, technical and artisan) developed by the Government or the private businessmen, the very thing which a company with "depth" and "experience" is not expected to do. As such, and as MEFCA originally maintained—and rightfully so—the result of this 'neighbour begging' has been a continuing wage-spiral as well as substantial increase in all fringe benefits and services. In conclusion, it can be stated that the experience of foreign management, be it in DAAPCO, KARDIGEILL, ELSELEIT, or KENANA SUGAR Factory*, has led to costly losses (both financial losses and/or unjustified high costs). We attribute this to one, some, or all of the following factors:

1. lack of relevant experience;
2. poor personnel calibre;

* These are private enterprises managed in their early implementation stages by foreign management.
3. inability to adjust to cultural and other external environmental constraints;
4. inability to adapt to hard geographical and climatic conditions; and finally;
5. the possibility of intentional financial and managerial misconduct.

However, it should not be construed that all foreign management is, by definition and in all circumstances, inadvisable.
CHART II: The Organizational Structure of Dalegty's Management

- Damazin Board

- Executive Committee

- General Manager/Project Manager

- Company's H.Q.

- Site Project Manager

- Administration Officer
- Maintenance & Mechanical Workshop Supervisor
- Agricultural Manager
- Livestock Dept. Officer
- Land Planning & Development Officer
- Damazin Liaison Officer
6.4. CURRENT MANAGEMENT OF THE SCHEME

A Sudanese team took over the management of the scheme just before the agricultural season of 1980-81. Sayed Abbas Abdel Magid, Advisor of Prince Mohamed Al Faisal during Dalegty’s era, has become the General Manager of the scheme and consequently the leader of the management team.

The current Sudanese management can best be described under the following headings:

6.4.1. Structure

At present, the Damazin organizational structure looks as follows:

(a) A Board of Directors which is in charge of:
   - establishing the objectives, policies and programmes of the scheme; and
   - the overall control and follow-up.

(b) The Executive Committee - this is composed of three members of the Board of Directors together with the General Manager. The idea behind this committee is to constitute a body which is more functional, that can meet more frequently and thus be in a position to provide help and advice to the General Manager in the day-to-day management of the scheme.

(c) The General Manager - the chief executive in charge of the daily management of the scheme and is responsible to the Board of Directors for the good management of the
human and physical resources of the scheme and the realization of its objectives.

(d) Primary Department at Headquarters - these are three departments which are located in Khartoum: Finance, Procurement, and Administration.

(e) Field Management - consists of the site project manager, an agricultural production unit, a maintenance workshop and a small storage unit.

(f) Service Units - the scheme has two service units, one in Port Sudan and the other in Damazin. The main task of both units is to facilitate the operations of the scheme in Port Sudan; namely, freight, shipping, customs' activities. In Damazin, the unit liaisons with the local government and the Government's Ginning Factory.

Generally speaking, this structure seems to be adequate for the purposes of the management of the scheme in its present size and with the present objectives. However, the structure and staffing of the Agricultural Equipment and Machinery Unit leaves a lot to be desired. Suffice here to say that the number, qualifications and training of the personnel who work in this unit are deficient. More attention will be given to these points in the final part of this section.

6.4.2. Terms of Service

In this part we are concerned with wages, salaries and other fringe benefits. In general, we can say that the wages, salaries and other benefits of the personnel of the Damazin scheme are rather poor in comparison with those of the public and private
schemes in the same region and those of less difficult regions.

Needless-to-say that this situation is neither conducive to attract high calibre personnel nor to the stability of the existing manpower. Again, this point will be further elaborated on under Recommendations.

6.4.3. Training

Training should have been dealt with in the above section, however, it is singled out here to give it more attention and emphasis since it was supposed to constitute a basic objective for DAAPCO and because it is one of the successful methods to attract young promising personnel and motivate them to stay with the scheme.

It is unfortunate to report that we have failed to find serious consideration towards training, be it a concrete training policy or a well laid out programme for training. The only exceptions are the short trips to Germany and the United States for the agricultural machine operators.

6.5. Manpower Availability:

Various aspects of the manpower situations of DAAPCO, the region, and the country as a whole have been alluded to in Chapters II, III, IV, V and VII. The supply of and the demand for the professional, technical, skilled and semi-skilled manpower has been well-documented in the five chapters referred to above. In this section special attention is given to the supply-demand situation of casual labour.

The final assessment of the manpower situation of casual labour is, here based on:
1. the isolated location of the scheme;

2. the fact that the scheme is located in a very sparsely-populated area;

3. the fact that the labour force, specially casual labour, in this region is not very committed to organized, disciplined work. This fact is well-manifested in the high turn-over rate among this category of workers;

4. The high demand for casual labour for bush-clearing, weeding, and harvesting;

5. the toughness of the environment, especially during the summer when water becomes very difficult to get (Water has to be fetched from as far as Damazine Town - 90 km from the scheme);

6. the almost complete lack of health and medical services in the neighbourhood in which the scheme exists.

Needless-to-say that the scarcity of water and medicinal and health services at the peak of the agricultural operations (March - April) means that DAAPOC has to shoulder these responsibilities for many workers (the figure for this year is 5000 workers). This figure will, definitely, go up if more area is devoted to cotton. The obvious conclusion to be drawn from this analysis is that mechanization of all agricultural operations is a must. The wages, and fringe benefits that casual labour has been demanding and getting are multiplying in very short spans of time. Hence, it should not be conceived that future expansion of the scheme and as a matter of fact even the present size - could be handled without heavy reliance on mechanization.
CHART III: The Organizational Structure of the Current Management

Board of Directors

Executive Committee

Port Sudan Office

General Manager

Damazin Office

DIRECTOR Administration

Site Project Manager

Director Procurement & Marketing

Director Finance
6.6. **RECOMMENDATIONS:**

As it has been stated earlier, the management and organizational structure of any enterprise should stem from and reflect the objectives, policies and programmes of operations of that enterprise. This implies that these objectives, policies and programmes of operations should be determined objectively, specifically and clearly before the pattern of management, the quantity and quality of management, the style of operation and the organizational structure are specified.

We have indicated in the above sections that DAAPCO has been undergoing drastic changes in its objectives, policies and programmes. We have also indicated that the interplay between the sharp changes in objectives and the frequent change of management (nationality, style and philosophy) has led to ambiguity, and in some cases to complete absence of direction, mission and overall purpose. Not only this, but we have further indicated that the stability and the eventual existence of the scheme are at stake. For example, we failed to find in the documents made available to us (the minutes of meetings of the Board of Directors, memorandums written by the General Manager, annual reports and more than three independent reports written by different consulting houses) any specific decisions concerning the total area that the scheme would eventually utilize, nor the crops that would be grown.

In the light of the aforesaid, our recommendations should be treated as tentative and as guidelines towards the necessary steps that have to be taken in the area of management and organizational structure.
Recommendation (1)

It could not be more stressed that the establishment of clear and specific objectives are the pre-requisites to successful management. Therefore, the shareholders of DAAPCO should decide, once and for all, and in a very clear statement of policy the objectives of DAAPCO. Once this is done, we believe that management (number, specializations, calibre, and experiences) as well as the organizational structure would automatically follow.

Recommendation (2)

Assuming that the present state of affairs continues (i.e., the size of the scheme remains more or less the same and that the crop pattern also persists): then we recommend the following:

(i) the number of middle level agriculturalists (graduates of higher agricultural institutes and/or high agricultural schools) should be increased to provide the necessary help and support to high level agriculturalists;

(ii) The clear deficiency in number and training of agricultural engineers and technicians should be quickly tackled with the intention of making the maximum use of the equipment and machinery already available or on its way to the scheme. We strongly believe that the level and depth of skills available do not match the huge invested capital in the scheme;

(iii) Despite the fact that in some cases performance is not very much related to age, qualifications, and experience; however, in most cases they are highly related. Having said this we believe that DAAPCO's
management should try to attract some personnel who are more qualified and experienced. Failing this, DAAPCO's management should embark on a very specific training programme (the advantage of this goes beyond staffing purposes and extends to the motivation and commitment of the young staff).

Recommendation (3)

Realizing that the organizational structure is a reflection of the activities needed to accomplish these activities; the authorities and responsibilities delegated to the managers in-charge of these activities; the communication networks that tie the different activities and units of the enterprise; and, assuming that the scheme's current objectives and activities will continue as they are, we believe that the current organizational structure is, to a great extent, adequate.

However, we recommend that the agricultural engineering activities should get more attention and thus, should be promoted to a full-fledged department comprising: agricultural engineering operations, maintenance and storage. At the head of this department there should be a qualified and experienced agricultural engineer who should be assisted by two highly qualified maintenance and mechanical engineers (See Chart IV).

Recommendation (4)

Considering the severe competition over professional, technical and skilled manpower and the markedly better terms of service available in neighbouring enterprises as well as the acute brain and skill drain by neighbouring countries, we recommend that DAAPCO should, immediately, bring its wages,
salaries and other fringe benefits in line with what other employers are paying. We have in mind here specifically the terms of service which are provided by employers such as the five companies of the Arab Authority for Agricultural Investment and Development. Needless to say that the details of this should be worked out after the principle has been approved by the Board of Directors.

Recommendation (5)

It has been indicated in the above paragraph that there is a high demand for the professional, technical and skilled manpower, both from within the Sudan or from the many neighbouring countries. In general, the supply situation does not match this demand particularly with regard to the technical and skilled manpower. This situation (i.e. the gap between the supply of and the demand for the three categories) is continuously aggravated as time goes on.

Therefore, we recommend that, in addition to the proposed improvements in terms of service suggested above, DAAPCO should pay serious and immediate attention towards the alleviation of this problem through a carefully conceived training programme. This programme should be based on realistic assessment of the growth rate and pattern of the scheme; the turnover rate of the personnel of the scheme over the past five years; the composition and profile of the present manpower and the supply situation.

CONCLUSION

We all tend to agree that the socio-economic development is made by the people and for the people. We are more convinced than ever that the success or otherwise of DAAPCO greatly hinges on the
CHART IV: The Organizational Structure of the Proposed Management

Board of Directors

Executive Committee

Port Sudan Office

General Manager

Damazin Office

Director Administration

Director Procurement & Marketing

Director Finance

Site Project Manager

Agricultural Operations

Field #1

Field #2

Field #3

Agricultural Engineer

Maintenance

Operations

Storage

- 93 -
attention and commitment given to the personnel who work in the scheme; whether management, professionals, technicians, skilled workers, unskilled workers or even casual labour.
CHAPTER VII
VII : FINANCIAL ANALYSIS

The economy of the Sudan has experienced a number of difficulties, during the past 5 years. Due to the huge investment in infrastructure and large-scale agro-industrial projects, financed mainly by expensive credits and at the expense of the agricultural sector, the country experienced large deficits in the balance of payments. On the other hand the stagflation which characterised the international economy has both decreased the foreign earnings of Sudan (mainly form cotton and other agricultural products) and sharply increased the cost of imports. As a result of all this the country was forced to devalue the national currency many times, and the exchange rate of the Sudanese pound which stood at about 2.8 American dollars as recent as 1978 has dropped in value to less than 50 (Fifty) cents by 1983.

As the rate of inflation in the Sudan is very high (officially estimated at about 30%) all assets are being appreciated. This raises a serious problem in evaluating the current value of the project assets, as they have been procured at various stages of the project life, and their book-value does not have any relevenc to their current market value. In the circumstances any financial analysis based on the book-value of the existing assets is apt. to give a positive result, which may be misleading for any entrepreneur if his decision to expand or reinvest is based on the result of that analysis. However, no attempt was made to evade this. The book-value of all assets was taken as a base and depreciated for the number of years during which the assets were functioning and the balance inserted in the column for the first year. On the other hand the current market price was taken for all replacements.

As the damazin project is exempted from all custom duties and taxes, these have been excluded and do not appear in the analysis.
There are a number of indicators for evaluating the financial viability of a project. These include the internal rate of return, the benefit/cost analysis, investment/cost analysis and the net present value. Out of these indicators the financial internal rate of return has been selected, as it is universally used by the majority of international organizations, including the World Bank.

From Chapter III it is shown that the project exploits at present some 51,000 feds and these are cultivated mainly with sorghum. The study, however, recommends that another rotation be adopted including sesame, cotton, sorghum and ground-nut, each occupying 25% of the area. The financial analysis was made for both rotations.

No attempt has been made to project the future development of the area allotted, and hence no analysis was made to such developments. The assumption being that such new development may be considered as replications of the existing phase, with the only qualification that the expanded project shall make use of the economies of scale in procuring inputs and marketing crops as well as in management.

**PROJECT INVESTMENT COSTS**

**Tree Clearance**

The land has been cleared of the trees over the past six years and in total 1.4 million pounds have been expended. As the cost of tree clearance has increased over the years from about seven Sudanese Pounds per fedan to thirty two Pounds the value of the cleaned land has been tremendously appreciated to about 1.6 million pounds. This amount appears as a revenue in year 15, the end year of the period analysed. On the other hand, for the purpose of the financial analysis only the expenditure incurred in the first year considered, 1982, amounting to five hundred pounds, has been included as an investment cost.
Machinery and Equipments and Vehicles:

As has been mentioned in para two of this chapter the book-values of the existing assets have been depreciated over the years utilized to obtain their current market value. But the current prices have been used to procure additional units at the appropriate replacement date, as can be shown from tables Nos. 2-9 in the appendix.

Buildings:

The office, workshops and residence compound have been established in the first years of the project. Similar to other assets the value of the buildings have been duly depreciated during the past five years to calculate their current book-value which was shown in table No. 1 in the appendix.

Total Investment Costs:

The following table No.15 gives the total investment costs as has been complied from the tables 1-9 in the appendix.

WORKING CAPITAL

The project has been functioning for the past six years and was making use of the interest-free financial facilities provided by Faisal's Islamic Bank. In the circumstances no allowance has been made for any working capital to finance the running expenses.

Running Expenses

These include such expenses as for seeds, fuel and lubricants, salaries and wages of the permanent staff, casual labour, social amenities, etc... For the purposes of the present analysis these expenses have been taken from the files of the management for the current 1982/83 and they were found to be about three million Sudanese pounds. Furthermore, these expenses are assumed to increase pro rata with the increase in area to 51 thousand acres in 1983/84 season, table No.16.
<table>
<thead>
<tr>
<th>ITEM</th>
<th>TREE CLEARANCE</th>
<th>BUILDINGS</th>
<th>LAND PREPARATION EQUIP.</th>
<th>TRACTORS</th>
<th>WORKSHOP TOOLS</th>
<th>SOWING MACHINERY</th>
<th>TRANSPORTATION</th>
<th>CONSTRUCTION MACHINERY</th>
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</table>

* Compiled from tables 1 - 9 in the appendix.
<table>
<thead>
<tr>
<th>Year/Item</th>
<th>Production Expenses</th>
<th>Transport Expenses</th>
<th>Administrative Expenses</th>
<th>Total Expenses</th>
<th>Contingencies (15%)</th>
<th>Grand Total</th>
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<td>2108262</td>
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<tr>
<td>CROP</td>
<td>PRODUCTION (TONS)</td>
<td>REVENUE SUDANESE POUNDS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------------------</td>
<td>-------------------------</td>
<td></td>
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</tr>
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<td>Sorghum</td>
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<td>1782703</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed Cotton</td>
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</tr>
<tr>
<td>Sesame</td>
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<tr>
<td>Soyabean</td>
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<td></td>
<td>6783284</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Salvage Value:**

When the commercial life of the scheme ends in fifteen years, as has been assumed in this analysis, the Damazin Company shall end with many assets. The most important asset shall be the cleared land, the value of which is estimated at present at about 1632 thousand Sudanese pounds. If the cost of tree clearance becomes more expensive in future, as expected, the value of this asset shall be relatively appreciated.

In addition to this the Company shall have some tractors and implements, as well as vehicles, which shall not have reached the end of their commercial life and can be sold. The estimated residual value of all these assets have been calculated as following:

<table>
<thead>
<tr>
<th>Asset</th>
<th>Estimated Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>1632</td>
</tr>
<tr>
<td>Land preparation equip</td>
<td>61</td>
</tr>
<tr>
<td>Tractors</td>
<td>175</td>
</tr>
<tr>
<td>Transport</td>
<td>85</td>
</tr>
<tr>
<td>Construction equip</td>
<td>10</td>
</tr>
<tr>
<td>Harvesters</td>
<td>264</td>
</tr>
<tr>
<td>Total</td>
<td>2227</td>
</tr>
</tbody>
</table>

The above sum has been included separately in table (18) of the internal rate of return.

*Soyabean is a new introduction in Sudan and as such the yield assumed is very low 0.15 ton/acre and the price adopted (450 Sudanese pounds/ton) FOB Fort Sudan.*

- 100 -
Project Revenue:

In the last 1982/83 season the productive area amounted to 37.7 thousand feds cultivated mainly with sorghum which covered about 33000 feds; cotton in 4000 feds and sesame in about 500 feds. The actual revenue obtained from the field crops according to the files was as follows:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>1701530</td>
</tr>
<tr>
<td>Cotton</td>
<td>899339</td>
</tr>
<tr>
<td>Sesame</td>
<td>4256</td>
</tr>
<tr>
<td>Total</td>
<td>2605125</td>
</tr>
</tbody>
</table>

In addition to this the management hires its fleet of trucks to transport the crops outside the scheme and for other purposes during the off season period. The workshop also hires its services to private farmers. Such revenue from these sources was estimated at 132.3 thousand pounds during 1982/83.

Therefore, the total revenue from the scheme amounted to 2937406 Sudanese pounds in the season 1982/83. When full 51000 acres are cultivated in the season 83/84 the expected revenue is estimated at 3656455 Sudanese pounds, table No. 17.

REVENUE EXPECTED FROM THE NEW ROTATION

The proposed rotation in chapter III (para 3.5) suggests that four crops be cultivated in the scheme including sorghum, cotton, sesame and soyabean, each occupying one quarter of the area. It is assumed that the project shall attain the average yields suggested by the technical team (table 2 page 18) and as such the revenue is calculated as following:

THE INTERNAL RATE OF RETURN OF THE PROJECT

The financial analysis of the scheme shows an internal rate of return of 33% as can be seen from the following table no. 18. This is an impressive rate. However it should not be considered in isolation of the following observations:
<table>
<thead>
<tr>
<th>Year/Item</th>
<th>Sorghum</th>
<th>Cotton</th>
<th>Sesame</th>
<th>Total Revenue from Crops</th>
<th>Other Revenue</th>
<th>Total Revenue</th>
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<td>1216612</td>
<td>5757</td>
<td>3524174</td>
<td>132281</td>
<td>3656455</td>
</tr>
</tbody>
</table>
1. The management has procured most of the assets in the early years, at a relatively cheaper price, and as a result of this the rate of return was so high.

2. This level of return shall not be sustained in future if the present monocropping pattern of cultivation is continued. As has been emphasized in chapter III continuous sorghum growing is very hazardous and in the long run shall deplete the soil and lead to the spread of the buda parasite which may devastated the whole endeavour.

3. The expected annual revenue from the proposed rotation is estimated at about 7 million Sudanese pounds and this is more than the total costs in any one year showing that the scheme can attain an internal rate of return of more than 50%.

4. In the body of the report reference was made to numerous recommendations which, if adopted, may guarantee the viability of the Damazin Project in all its phases.
### APPENDIX

#### INTEGRAL RATE OF RETURN

<table>
<thead>
<tr>
<th>Year</th>
<th>Investment Costs</th>
<th>Running Costs</th>
<th>Total Costs</th>
<th>Total Revenue</th>
<th>Cash Flow</th>
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<td>1231955</td>
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**Irr = 33.0%**
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