

SN
604.1228
N434

PN-AMM-525
ISN = 27817

62

**DEVELOPING OUTLETS FOR DURA
IN THE SUDAN**

**Supplemental Report to Report III
of Contract AID/afr-228**

on

Wet Milling Process

Prepared for

The Agency for International Development

and

The Government of the Sudan

January 1966

**A. S. NEMIR ASSOCIATES
1018 Warner Building
Washington, D.C.**

**A.I.D.
Reference Center
Rm. 2000**

A. S. NEMIR ASSOCIATES
INDUSTRIAL, ECONOMIC, FOREIGN TRADE CONSULTANTS

PHONE:
737-6536

WARNER BUILDING
SUITE 1018
WASHINGTON, D. C. 20004

December 22, 1965

Agency for International Development
Department of State
Washington, D. C. 20523

Re: Contract No. AID/afr-228
Supplemental Agreement No. 1

Gentlemen:

On July 16, 1965, I met with the following AID officials in the Office of Capital Development and Finance:

Saul Nelson	AID/AFR/CDF
Richard Greene	Loan Officer - Sudan
Tom Miaola	CDF/ENGR
Dennis Conroy	Sudan AID Desk Officer
Fred Preu	CDF - Private Enterprise Office

The subject of discussion was assistance to AID in connection with evaluating a loan application for a wet milling plant to produce starch and glucose in the Sudan.

It was agreed that additional assistance to AID in appraising the application would be of value because the Applicant's request was for a 70-ton plant requiring a substantially larger capital investment than proposed in my February report.

An agreement was reached under which a contract was drawn providing that I would proceed from Brazil to Khartoum to be available during the week beginning July 26, 1965 when Mr. William B. Wheeler, Chief of the Mediterranean Division, would be present to consider the various aspects of the loan application. It was further understood that after the field trip, two and a half weeks in the home office in Washington would be provided for consultation as requested by the Project Manager and for appraisal of the application. The principal responsibility under this arrangement was to re-check the estimates in the Sudan for dura products in order to resolve the variance between the Applicant's proposal and the recommendation of the previous Nemir Associates report.

I took brief notes on my activities in Khartoum during the week July 26 to August 1, 1965. The transcribed notes, unedited, are available to AID/Washington upon request for informational purposes.

Major Activities

1. Meetings were held each morning with the AID Director in Khartoum.
2. Several meetings were held with Mr. Henry Nadler, the Applicant's prospective plant manager, and Mr. Ismail el Madhi, Public Relations Officer of the proposed company.
3. We visited the prospective users of starch and glucose in the major fields.
4. We also visited with officials in the Ministry of Industry and Commerce and other officials in the Government of the Sudan.

Observations

Major efforts were to re-examine the demand for starch and glucose as estimated in the Applicant's proposal.

In the report prepared by my firm in February 1965, in the table on page 17, a projection of dura potential for wet milling operation was summarized. This table was projected only on existing usage in the Sudan for two industries - the textile industry for starch and the confectionery industry for glucose.

It was stated in the report that these data did not include allowances for increased utilization in other industries. The 25 to 50 ton plant recommendation was based upon the projected market beginning in 1967 calculated on existing business and provided for modest usage in other areas soon after the plant came into operation.

The loan application under consideration differed primarily in that first, a larger usage by existing consumers of both starch and glucose was projected, and second, the immediate capture of new potential business in the first years of operation was assumed.

Procedure

In Khartoum

Each of the major projections by the Applicant (APRC) in starch and glucose were analyzed in the field through discussions with leading existing business groups.

Also, at Mr. Wheeler's request, information was obtained on prices for both starch and glucose. This question was given a great deal

of attention and was examined in the light of the following criteria:

1. The existing price paid by the major users, including the breakdown of costs from CIF to an on-site basis.
2. The economically justifiable price that could be charged from the point of view of approving the establishment of a new industry.
3. The future course of prices.

In Washington

Following my return from the field I met with AID officials in their Washington office at which time Mr. W. O. Cooper, the AID Director in the Sudan, officials of AID/Washington and principals of the Applicant, including Mr. William Summers Johnson, President, Council for Evaluation of Economic Programs, and the two Nadler brothers were present.

Two major points were emphasized at this meeting. First, that our review of projected demand for starch and glucose did not justify a plant of the size contemplated without including dextrose as a part of the operation, and second, that the application was not complete enough in terms of the usual definitive engineering details for this type of specialized manufacture.

Following the meeting, AID/Washington took steps to require that the application be accompanied by a competent engineer's specification and plant lay-out which would include facilities to produce a limited amount of dextrose.

Later, in a telephone conversation, Mr. Wheeler, Loan Officer for North Africa, informed me that the investment group had changed somewhat and were going ahead but on the basis of the re-grouping and re-application which would include among the interested parties a starch manufacturing concern knowledgeable in the field of the products to be manufactured. He asked that I proceed to prepare and submit a report to cover the questions previously listed in the contract which dealt with the ideal size of the facilities based on reasonable firm potential sales projection, including the three main products, starch, glucose and dextrose. He further asked that we give attention to the price of these products as a part of the determination of the economic feasibility as well as economic rationalization.

Mr. William Rainey of my office continued to work on the project,

taking into consideration two substantive changes from the previous project.

1. The acceptance of a 16-hour a day operation, and
2. The inclusion of dextrose as a commodity to be produced.

In mid-October we met with Mr. Anderson, AID/Washington, in his office to review in general our preliminary findings and to discuss the AID point of view on the engineering aspect of the project.

On November 3, 1965, Mr. Rainey and I met with Mr. Wheeler and Mr. Anderson to give orally our tentative findings and to discuss any special questions before proceeding to give our final report in writing.

It should be noted that the more extensive time required to complete our report was due to the changes not contemplated in July when the agreement for additional services was made. It was apparent that the Applicant's proposal could not be supported by our findings with reference to the current demand for starch and glucose, and certainly with the smaller volume could not justify a 70 ton a day basis 16 hour operation.

When it was determined in Khartoum during our visit the last week of July 1965 that the Government of the Sudan would consider limited production of dextrose, the proposal of the Applicant was then brought in line; e.g., the volume of sales potential permitted an economically feasible project based on a 16-hour a day operation and the erection of a plant with capacity larger than we had proposed in our original report.

Findings

1. The projection of demand in the Sudan over the period 1968 to 1978 for starch in the textile industry and glucose in the confectionery industry as given in the February 1965 report remains materially unchanged.

2. Plant, machinery and equipment costs were computed in our February 1965 report on the basis of a 24-hour a day operation. Upon adjusting these costs for the larger plant required to produce the same products in a 16-hour day as on a 24-hour day basis, the cost per ton of dura processed is virtually the same. We estimate that plant, machinery and equipment costs for a 50 tons per 16-hour day operation would be a little over \$61,000 per ton of capacity, which compares with the Applicant's calculated cost per ton of about \$63,000 for a 70-tons per 16 hours a day plant.

3. A review of the prices paid for glucose and starch in the respective industries indicated that the prices for both products were very close to the international price level after allowing for transportation and port charges. Variations were limited to about 10 percent.

The price for starch varied much greater than the price for glucose reflecting different technical requirements for starch in the textile industry compared with a more uniform grade of glucose in the confectionery industry. All of the price information obtained was based on direct purchases by the user in relatively large quantities. Therefore, these prices do not reflect to any marked degree middlemen charges normally associated with more extensive product sales where mark-up to cover selling and handling expenses on a broader basis would be required.

4. An interview with officials of the Ministry of Industry and Commerce in the Sudan indicated that a limited production of dextrose would not be opposed by the Government of the Sudan.

5. Allowing approximately two years for the completion of plans and specifications and for plant erection, 1969 would be the earliest period to expect a full operational year.

Conclusions

1. The inclusion of dextrose as a product to be manufactured requires a plant almost twice the size recommended in our February 1965 report. The report contemplated a plant beginning with around 6,000 tons of dura and reaching over 10,000 tons over a ten year period. The inclusion of dextrose would permit an increase of from 5,000 tons to as much as 8,000 tons additional dura grinding.

2. The larger plant makes it economically feasible to operate on a 16-hour a day basis rather than on a 24-hour a day basis as previously contemplated. The higher income from the larger plant will support the additional per unit cost involved in the 16-hour a day operation.

3. I have been informed that the revised application will include a comprehensive plant and equipment plan with supporting cost data by a competent engineering firm. This would substantially strengthen the application.

4. Added strength would also be given to the project if the investment group were to include a U.S. firm knowledgeable in the field of manufacturing and selling wet milling products.

5. A fixed price criterion is virtually impossible to establish because of the technical differences in the products to be manufactured and the wider distribution contemplated by the new plant. However, the prices used in projecting potential sales are within 10 percent of the cost at international prices now being paid by the larger users. The greatest variation in prices occurs in the price paid for starch. The revenue from the sale of starch as projected in our estimate represents less than 10 percent of total revenue. This means that any changes in the income from starch as a result of modification of starch prices would not affect total income enough to affect the economic feasibility of the project.

Under the Industry Assistance program it would be reasonable to allow relatively higher prices in the first few years of operation and to reduce those prices after the project is in full operation. This is particularly true in the case of dextrose where the initial volume in the first year of operation is assumed to be 1,000 tons with progressive increases up to 5,000 tons. For this type of industry where fixed charges are high the progressively increased volume permits the lowering of costs per unit of output.

For the purpose of projecting revenue obtained from prospective sales of all products manufactured the following average price assumptions were made.

	<u>LS. M. Tons</u>	<u>US \$ M. Tons</u>
Glucose	64	184.96
Dextrose	100	289.00
Starch	60	173.40
Feed	9	26.00
Oil	80	231.20

6. Since 1969 is likely to be the first full year of operation, there would be about two years in which industrial expansion could be expected and growth of demand could be anticipated, thus creating a broader base of commercial food processing.

The foregoing conclusions are discussed in greater detail in the attached Memorandum covering four broad categories:

1. Demand potential and size of plant required.
2. Approximate cost of plant.
3. Prices of the finished product.
4. Estimated potential income.

Recommendations

It is recommended that consideration be given to an application for a plant of approximately 50 tons a day capacity on a 16-hour a day basis. This plant would be designed to satisfy projected demand which will require initially about 10,000 tons of dura per year and will expand to 20,000 tons of dura over the ten year period. In the first year of operation utilization of a little over 50 percent of capacity on a 275-day running time is anticipated and is projected to reach 100 percent of capacity by the fifth year of operation. The projected increases are as follows:

1st year	56%
2nd year	71%
3rd year	81%
4th year	92%
5th year	100% ÷

It should be noted that in the second half of the ten year period, plant capacity can be increased by shifting to a 24-hour a day operation. On the basis of the 24-hour a day operation in the 6th year, the projected plant capacity is 75% and progressively increases to 93% in the 10th year.

The substance of this projection is that a 50 tons a day plant is the minimum size warranted under the assumptions made.

In view of the nature of the operation, in addition to the capital cost for plant equipment which we have projected to be around \$61,000 per ton of production, it would be essential that adequate funds be made available for working capital.

Respectfully submitted,

A. S. NEMIR ASSOCIATES



A. S. Nemir
President

ASN:kh
Attachment

MEMORANDUM Supporting Findings and Conclusions
as Reported to Agency for International
Development, Washington, D.C. in Letter of
December 22, 1965

Re: Contract No. AID/afr-228
(Supplemental Agreement No. 1)

C O N T E N T S

1. Demand Potential and Size of Plant Required
2. Approximate Cost of Plant
3. Prices of the Finished Product
4. Estimated Potential Income

I. Demand Potential and Size of Plant Required

Demand Potential

Starch and Glucose. The demand for starch and glucose as given in the February 1965 report to AID entitled "Developing Outlets for Dura in the Sudan" was re-appraised by revisiting during the week of July 26, 1965, the firms in the Sudan currently using these products. An on-the-spot appraisal of potential demand for starch and glucose as projected by the Applicant was made. Because of the wide differences between the Applicant's projected demand for starch and that contained in our report, starch was the first item to be re-appraised.

The use of starch in four major categories was examined first. These were textiles, paper, soap and confectionery. There is given on the following page a tabulation comparing the estimates of starch consumption projected for the year 1970 of both the original February 1965 report and the Applicant's projection. While it is possible that, as stated by the Applicant, quantities of starch were imported into the Sudan under special categories not shown in the Sudanese import statistics, it is doubtful that these imports were in substantial amounts. Some starch is used in confectionery but the amount is small. Similarly, small quantities could be used in cosmetics, biscuits, and custard powders. The quantities of starch projected in Table I, page 3, are limited to the textile industry.

The projected 725 tons for 1970 were divided as follows:

Sudanese American Textile Company	500 Tons
Khartoum Spinning & Weaving Company	200 "
Confectionery	<u>25 "</u>
Total -	725 Tons

In computations made in this report we have confined the demand projections, with the exception of dextrose, to known usage. Therefore, the tables summarize projected income and running time and include only estimates based on existing usage projected at an assumed rate of increase for the ten year period. Purely as a matter of judgment on our part, we believe it reasonable to make some additions on the basis of potential additional markets not now existing and primarily based upon new users being brought into the market. These projections are given in Table II, page 6, and are limited to the addition of 2,500 tons dura base by 1970 (or possibly 1971), or the third year of operation, and 3,690 tons in the tenth year of operation.

**COMPARISON OF ESTIMATES OF STARCH CONSUMPTION
IN THE SUDAN 1970**

<u>Industry</u>	<u>Nemir February 1965 Report</u>	<u>II-43 APRI</u>
Textiles	700	3,000
Paper	0 <u>1/</u>	2,000
Soaps ;	0 <u>2/</u>	2,600
Cosmetics	0	350
Adhesives	0	600
Pharmaceuticals	0	500
Confectionery	25 <u>3/</u>	1,500
Beer	0 <u>4/</u>	300
Biscuits	0 <u>5/</u>	300
Custard Powders	0 <u>6/</u>	600
Total -	<u>725</u>	<u>11,750</u>

(revised)

- 1/ The use of starch in the type of paper manufactured in the Sudan was not determined.
- 2/ It was established that no starch is now being used in any phase of soap manufacture in the Sudan. See Nemir log, pages 3, 4, 6. Investigation regarding its use in soap-making in the United States shows no use either in process or finished product.
- 3/ Interviews in the Sudan indicated no significant amounts being used. Nemir Log, page 3. Also interviews at Saad Sweets, Nyikab and African Confectionery. 12/4/64.
- 4/ Corn grits, sorghum grits and soy grits are used in beer production in the U.S. and corn grits in Sudan, but no starch.
- 5/ Considering the type of flour presently being milled in the Sudan and present laws covering the type of flour that is permitted, the addition of bleach and improvers by the flour mill, it does not appear feasible to make a satisfactory biscuit and cracker flour locally. This type of flour will probably continue to be imported and will be suitable for biscuit and cracker manufacture without any addition of starch.
- 6/ Starch is used in this type of product but the extent of use in the Sudan was not determined by Nemir Associates.

TABLE I

**PROJECTION OF ESTIMATED DEMAND, IN THE SUDAN, FOR STARCH IN THE
TEXTILE INDUSTRY, GLUCOSE IN THE CONFECTIONERY INDUSTRY, AND
DEXTROSE AS A PARTIAL SUGAR (SUCROSE) SUBSTITUTE**

(Metric Tons)

Year	Starch in Textiles	Dura Equivalent	Glucose in Confectionery	Dura Equivalent	Dextrose as Sugar Substitute	Dura Equivalent	Total Dura
1968	641	1,165	3,537	4,823	1,000	1,724	7,712
1969	682	1,240	3,749	5,112	2,000	3,448	9,800
1970	725	1,319	3,974	5,419	2,600	4,483	11,221
1971	768	1,396	4,212	5,743	3,200	5,518	12,658
1972	814	1,480	4,465	6,089	3,800	6,552	14,121
1973	863	1,569	4,730	6,450	4,400	7,586	15,605
1974	915	1,664	5,014	6,837	5,000	8,621	17,123
1975	970	1,764	5,315	7,248	5,000	8,621	17,632
1976	1,030	1,873	5,634	7,683	5,000	8,621	18,175
1977	1,092	1,986	5,972	8,143	5,000	8,621	18,750
1978	1,158	2,105	6,330	8,633	5,000	8,621	19,359

The Dura requirements are based on the following assumptions:

A yield of 55% starch from dura	$\frac{55}{75}$	= 73%
An increase in weight of 25% for glucose	$\frac{55}{95}$	= 58%

Dextrose. The most significant factor in re-appraising the investment potential was the fact that officials in the Sudan, when visited in company with representatives of the Applicant, indicated that limited production and sale of dextrose would not be blocked by Government action. Any estimate of the use of dextrose has to be on a subjective basis since it is not used as a commercial sweetener at the present time in the Sudan.

Considering that the raw material dura is in surplus and that the starch derived from the dura can be economically produced, the manufacture of dextrose in limited amounts would have beneficial effects in terms of lower cost in producing glucose and starch. Furthermore, since the existing two sugar plants, even at full production, will not meet the total sugar requirements of the Sudan, the use of a small quantity of dextrose would conserve foreign exchange.

Dextrose produced in small quantities can be rationalized as being in the national interest in the Sudan since the raw material dura is economically produced and, since the addition of only small capital costs will provide for the conversion, the inclusion of dextrose among the products to be processed in a wet milling plant is sound.

The rationalization for setting a target beginning at 1,000 tons and going up to as high as 5,000 tons is based on the fact that this will be only about 3 percent of total sugar consumption. The projection of sugar consumption in the Sudan is given in Report I of Contract AID/afr-228 "Developing Outlets and Markets for Sudanese Molasses", Table No. 1. It will be seen from that table that the 1968 usage of sugar (sucrose) in the Sudan was projected to be 150,000 metric tons. The projected production of 120,000 tons by the two sugar plants in the Sudan would still require imports of sugar from 35,000 to 50,000 metric tons.

In dividing consumption between household and industrial uses for the ten year period under consideration; i.e., 1968 to 1978, it may be safely assumed that industrial usage will be around 20 percent of this total, or approximately 30,000 metric tons.

These 30,000 metric tons will cover all types of industrial uses such as soft drinks, fountain syrups, confectionery, biscuits and crackers, sweet goods produced in the baking industry, and in all other food processing, such as food canning, etc.

Just as was the case in the confectionery industry, it may be expected that the use of sugar by industrial consumers and food processors would increase as the population grows. In other words, the growth factor for the industrial use of sugar is a composite of economic growth, urbanization trend, and population increase.

Under the umbrella of high sugar prices a market for dextrose in the area of 3,000 to 5,000 metric tons is wholly feasible. Some allowance should be made for the gradual increase in the use of dextrose as a partial sweetener replacement for sucrose; i.e., the first year 1,000 metric tons, the second year 2,000 metric tons, the third year 3,000 metric tons, etc., up to a determined limit. At this stage it would probably be wise to limit the foreseeable production of dextrose to 5,000 metric tons per year.

	<u>Dextrose</u>	<u>Dura Required</u>
	(Metric Tons)	
1968	1,000	1,724
1969	2,000	3,448
1970	2,600	4,483
1971	3,200	5,518
1972	3,800	6,552
1973	4,400	7,586
1974	5,000	8,621
1975	5,000	8,621
1976	5,000	8,621
1977	5,000	8,621
1978	5,000	8,621
1979	5,000	8,621

Table I combines the dura for dextrose with the projection shown for starch and glucose. It will be seen that when dextrose is added to the list of products that it approximately doubles the processing requirements.

TABLE IIOTHER POTENTIAL MARKETS FOR STARCH AND GLUCOSES T A R C H

	<u>1968</u> M.T.	<u>1970</u> M.T.	<u>1978</u> M.T.
Pharmaceutical	50	100	150
Confectionery	50	100	200
Custard Pudding	100	200	300
Adhesives	--	50	100
Miscellaneous	<u>100</u>	<u>100</u>	<u>300</u>
Total -	300	550	1,050
Dura required (M.T.) -----	545	1,000	1,909

G L U C O S E

	<u>1968</u> M.T.	<u>1970</u> M.T.	<u>1978</u> M.T.
Fruit & Vegetable Canning	200	500	650
Soft Drinks	200	300	300
Biscuits	<u>200</u>	<u>300</u>	<u>350</u>
Total -	600	1,100	1,300
Dura required -----	820	1,507	1,781

TOTAL DURA REQUIRED (STARCH AND GLUCOSE) 1,365 2,507 3,690

TABLE III

Projection of Estimated Demand
For Starch in The Sudanese Textile Industry
And Glucose in the Confectionery Industry
For the Calendar Years 1968 to 1978

Year	(1) Estimated quantities of starch used in the Textile Industry	(2) Equivalent Dura	(3) Estimated Usage of Glucose in the Confectionery Industry	(4) Equivalent Dura	(5) Total Dura
1968	641	1,165	3,537	4,823	5,988
1969	662	1,240	3,749	5,112	6,352
1970	725	1,319	3,974	5,419	6,738
1971	768	1,396	4,212	5,743	7,140
1972	814	1,480	4,465	6,089	7,569
1973	863	1,569	4,730	6,450	8,019
1974	915	1,664	5,014	6,837	8,502
1975	970	1,764	5,315	7,248	8,011
1976	1,030	1,873	5,634	7,683	9,554
1977	1,092	1,986	5,972	8,143	10,129
1978	1,158	2,105	6,330	8,633	10,738

NOTES:

- (1) Based on present use figures as reported by textile manufacturers.
- (2) Based on 55% starch extraction.
- (3) 1963 Imports glucose 2,418 M.T.
Imports glucose 1st 6 mo. 1963 - 1,103 M.T.
Imports glucose 1st 6 mo. 1964 - 1,349 M.T.
Imports glucose 1st 8 mo. 1964 - 1,650 M.T.
- (4) Based on expressing glucose on a starch basis by using a factor of 75% and applying the factor as in (2) to obtain dura required, we have the relationship of $\frac{55}{75}$ or 73.3%.
- (5) Column (2) plus Column (4).

The foregoing table is a slight revision of the data appearing in the table on page 17 of the February 1965 report. The figures are embodied in Table I which includes dextrose.

Size of Plant Required

After considerable trial and error analysis we have concluded that a 50 ton a day plant on a 16-hour basis more nearly meets the requirements of capacity to achieve our projection of demand for the major manufactured items (starch, glucose and dextrose) including by-products (oil and feed).

The projection of demand for starch and glucose is essentially the same as our original findings with only minor increases. Little allowance is made for the additional demand which the investment group envisage in its application.

In recommending a plant initially with a capacity of 50 tons a day on a 16-hour basis, certain assumptions were made as follows:

1. The number of practical operating days would be 275 in each calendar year.
2. Extraction of starch would be at 55 percent of each ton of dura processed. Practical operation may demonstrate that this may be somewhat high depending on the type of dura obtainable.
3. In the first few years of operation the maximum of 275 days will not be achieved.
4. The 16-hour, 2-shift basis, has been assumed for the first five years with a change to a 3-shift, 24-hour basis in the second five years.
5. Projections were limited to an appraisal based on a list of approved and assisted industries in current production with certain reservations as to a few firms that were in production but have experienced operating difficulties.

Therefore, if the Applicant can demonstrate that certain firms now in production or to go into production will begin the use of starch or starch products, our estimates as given in the summary tables would have to be appropriately modified.

The application of the above assumptions to the projected demand is incorporated in Tables IV and V.

Table IV shows that a shift to a 24-hour basis would be necessary by 1972 and that the full plant potential would come into use during a ten year period. Should the Applicant demonstrate that demand would be greater than herein assumed, a plant larger than 50 tons a day, 16-hour basis, could be justified.

Tables VI, VII and VIII contain data dealing with capacity and running time combinations and are included to illustrate the type of data used as background for reaching our conclusions.

TABLE IV

PROJECTION OF POTENTIAL ANNUAL RUNNING TIME
(Basis capacity 50 tons per 16-hours)

Year	Dura Required for Starch, Glucose and Dextrose (Metric Ton) <u>1/</u>	Number of Days Required to Produce		Percent of Running Time Basis 275 Days	
		Basis 16 Hrs.	Basis 24 Hrs.	16 Hrs.	24 Hrs.
1968	7,712	154		56%	
1969	9,800	196		71%	
1970	11,221	224		82%	
1971	12,658	255		93%	
1972	14,121	283		-3%	
1973	15,605		208		76%
1974	17,123		229		83%
1975	17,632		235		85%
1976	18,175		243		88%
1977	18,750		250		91%
1978	19,359		258		94%

1/ See Table I

TABLE V**PRODUCTION**

**Plant Designed for 50 Metric Tons Per Day on
16-Hour - 2-Shift Basis**

**Table Based on 275 Day Running Time Per Year
Dura Grind 13,750 Metric Tons**

Year	Dura for Starch and Glucose (1)	Dura for Dextrose (2)	Total Dura for Starch, Glucose & Dextrose (3)	Excess or Deficit Dura (4)
1968	5,988	1,724	7,712	+ 6,038
1969	6,352	3,448	9,800	+ 3,950
1970	6,738	4,483	11,221	+ 2,529
1971	7,140	5,518	12,658	+ 1,092
1972	7,569	6,552	14,121	- 371

**Operation Changed to a 24-Hour, 3-Shift Basis
Grinding 75 Metric Tons of Dura Per Day or
20,625 Metric Tons Per Year**

1973	8,019	7,586	15,605	+ 5,020
1974	8,502	8,621	17,123	+ 3,502
1975	9,011	8,621	17,632	+ 2,993
1976	9,554	8,621	18,175	+ 2,450
1977	10,129	8,621	18,750	+ 1,875
1978	10,738	8,621	19,359	+ 1,266

NOTE: All figures basis annual production.

- (1) Dura required for current known market for starch and glucose in textile and confectionery industries and projected increase for these two industries only, at rate of 6% per year.
- (2) Assumed market for dextrose.
- (3) Sum of columns (1) and (2).
- (4) Excess or deficit of dura processed needed for starch, glucose, and dextrose on the basis of assumed running time.

TABLE VICAPACITY - RUNNING TIME COMBINATIONS

<u>Metric Tons Ground</u>		<u>RUNNING TIME</u>	
<u>Per Day</u>	<u>Per Year</u>	<u>Hours Per Day</u>	<u>Days Per Year</u>
40	8,000	16	200
"	10,000	"	250
"	11,000	"	275
"	12,000	"	300
60	12,000	24	200
"	15,000	"	250
"	16,500	"	275
"	18,000	"	300
50	10,000	16	200
"	12,500	"	250
"	13,750	"	300
"	15,000	"	300
75	15,000	24	200
"	18,750	"	250
"	20,625	"	275
"	22,500	"	300
50	10,000	24	200
"	12,500	"	250
"	13,750	"	275
"	15,000	"	300
33-1/3	6,666	16	200
"	8,333	"	250
"	9,167	"	275
"	10,000	"	300

TABLE VIICAPACITY RUNNING TIME COMBINATIONS

<u>Days Operated Per Year</u>	<u>Metric Tons Ground Per Day</u>	<u>Per Year</u>	<u>Hours Per Day</u>
<u>200</u>	33-1/3	6,666	16
"	40	8,000	16
"	50	10,000	16
"	50	"	24
"	60	12,000	24
"	75	15,000	24
<u>250</u>	33-1/3	8,333	16
"	40	10,000	16
"	50	12,500	16
"	50	"	24
"	60	15,000	24
"	75	18,750	24
<u>275</u>	33-1/3	8,167	16
"	40	11,000	16
"	50	13,750	16
"	50	"	24
"	60	16,500	24
"	75	20,625	24
<u>300</u>	33-1/3	10,000	16
"	40	12,000	16
"	50	15,000	16
"	50	"	24
"	60	18,000	24
"	75	22,500	24

TABLE VIIICAPACITY RUNNING TIME COMBINATIONS(Metric Tons Dura Ground)

<u>Per Year</u>	<u>Per Day</u>	<u>Hours Per Day</u>	<u>Days Per Year</u>
6,666	33-1/3	16	200
8,000	40	16	200
8,333	33-1/3	16	250
9,167	33-1/3	16	275
10,000	33-1/3	16	300
10,000	40	16	250
10,000	50	16	200
10,000	50	24	200
11,000	40	16	275
12,000	40	16	300
12,000	60	24	200
12,500	50	16	250
12,500	50	24	250
13,750	50	16	275
13,750	50	24	275
15,000	60	24	250
15,000	50	16	300
15,000	75	24	200
15,000	50	24	300
16,500	60	24	300
18,000	60	24	300
18,750	75	24	250
20,625	75	24	275
22,500	75	24	300

2. Approximate Cost of Plant

Introductory Notes

Based on previous meetings with AID/Washington and telephone conversations, it is understood that provision will be made to have a competent engineering firm design and present cost estimates before any plant is approved. Therefore, our brief notes reviewing the cost estimates are given for orientation purposes only. It was necessary for us to go through the exercise in order to form an opinion regarding the economic feasibility of a larger plant in terms of higher costs.

A 16-hour operating schedule for this type plant is not ordinarily desirable but it is feasible and is being done where local conditions dictate. Grain can be left in steep tanks and starch may be left in slurry tanks for a maximum of 48 hours, with proper adjustments in operation. However, finished product lines and feed drying equipment must be cleared at the end of each 16-hour period.

Machinery and Equipment Requirements

In view of the acceptance or adoption of a 16-hour a day operation it was necessary to review our original study in order to determine the cost of a plant having 50% greater capacity. As a rule of thumb, the experience in the industry indicates that a factor of 60% increase in costs for machinery and equipment is required in going from a 24-hour a day basis to a 16-hour a day operation and maintaining the same production.

The 60% factor was not used for other cost increases as illustrated by the indicated rates applicable to the following items:

Building	25% increase
Cost of Installation	50% "
Transportation & Equipment	40% "
Spare Parts	50% "
Other tools and Equipment	25% "

In accepting the principle of producing limited quantities of dextrose it was necessary to add the cost of dextrose processing equipment to our original estimates and \$320,000 was projected for this purpose. A further adjustment was made by increasing our estimate of cost of engineering from 10% to 15%.

The above assumptions are reflected in the following computations giving capital costs of a plant to produce 50 metric tons per day based on a 16-hour a day operation:

Land Improvement	\$ 50,000
Grain	120,000
Buildings	170,625
Machinery and Equipment	1,857,600
Freight to Central Sudan	184,000
Cost of Installation	187,500
Transportation Equipment	65,800
Furniture & Fixtures	1,200
Spare Parts	75,000
Other Tools & Equipment	68,750
Engineering	278,640
Cost of Plant (excluding land cost) -----	\$ 3,059,115

Direct Labor Costs

For the purpose of this analysis the same labor costs as used in our original study are projected:

Direct Labor Cost on basis of 74 employees,
275 days, 16-hour day ----- \$ 74,675
(Appendix 1, page 11, Dura Report)

In the second five years of operation in converting to a 24-hour a day basis requiring an increase in employees, the direct labor cost on a 275 day, 24-hour a day operation, increases to \$88,748.

Manufacturing Overhead

It was convenient to use our computations as shown in Appendix 1, Page 12 of the Dura Report, which gives an estimate of \$78,550 as the approximate cost.

Depreciation

We made no change in our depreciation rates. In the table below we applied these rates to the increased costs:

Buildings- 20 years	\$ 8,530
Grain storage - 15 years	8,000
Machinery & Equip. - 12 yrs.	185,760
Transportation - 5 years	13,160
Furniture - 8 yrs.	150
Other Tools & Equip. - 8 yrs.	8,600
Total Depreciation -	<u>\$224,200</u>

Cost Per Ton of Dura Processed

The costs for machinery and equipment are compared on a basis of cost per unit capacity.

1. Cost per ton of dura processed for 50 ton plant, 16-hour a day ----- \$ 61,182
2. Using this per unit cost a 70 ton a day plant, 16-hour a day basis would be projected at ----- \$4,282,740
3. The APRI estimate of \$4,065,000 when adjusted for the addition of dextrose processing equipment at our estimate of \$320,000 (or a total of \$4,385,000) results in a cost per ton of ----- \$ 62,643
4. While it is previously noted that the costs are not straight line changes it is interesting to note that the cost per ton of processing dura of the two independently arrived at estimates are quite close; i.e., on 70-ton basis:

APRI	\$ 62,643
Nemir	\$ 61,182

Working Capital Requirements

Additional funds will be required for working capital. No effort is hereby made to determine the limits as this is largely a matter of negotiation in the light of local conditions and trade practices. The figures below, taken from the Applicant's report, illustrate the major categories to be covered:

	<u>1st Year</u> <u>40 M.T. Dura</u>	<u>5th Year</u> <u>70 M.T. Dura</u>
Dura storage	152,000 ^{1/}	216,000
Inventories (30 days)	148,000	213,500
Other Raw Materials & Supplies, (90 days)	100,000 ^{2/}	140,000
Collections (90 days)	442,000	750,000
Contingency for delayed collec- tions	150,000	250,000
Start-Up Expenses	<u>100,000</u>	-----
	<u>1,092,000</u>	<u>1,569,000</u>

1/ Dura storage the first year covers 90 days use; in the 5th year, 30 days use.

2/ Includes sulphur, acid, alkali, heating oil, containers, and other packaging materials, plant cleaning materials and office supplies and lubricants.

The working capital requirements for a 50-ton plant, if this is the size accepted, would lie in between the above figures for the 40 ton plant and the 70 ton plant. The decision as to the amount to be permitted for these items should be determined on the basis of the new application including the size of the plant decided upon.

3. Prices of the Finished Product

There are five products on which price assumptions must be made. They are, in order of importance, glucose, dextrose, starch, feed and oil.

For the purposes of estimating revenue to be derived from the sale of these products the following assumptions were made:

	<u>Sudanese</u> <u>Pounds</u>	<u>U. S.</u> <u>Dollars</u>
	(Per Metric Ton)	
Glucose	L\$ 64	\$ 184.96
Dextrose	100	289.00
Starch	60	173.40
Feed	9	26.00
Oil	80	231.20

A brief discussion of each assumption is in order.

Glucose. The price shown for glucose is based on the current price at plants in Khartoum. Glucose is currently used in the confectionery industry and, under the Industry Assistance Act, is exempt from the payment of duty. The price, therefore, is based upon the world market export price plus cost of shipment from Port Sudan to the plant in Khartoum. The type of confectionery produced in the Sudan and the existing climatic conditions both require the use of glucose in the manufacture of confectionery. Therefore, the only question involved is one of determining that the proposed plant can produce glucose efficiently of the type desired within the price limits above.

The export price of glucose from West European countries is generally sold below or at the wholesale price level existing in the exporting countries for their own domestic consumption. It can be assumed that after the period of exemption allowed under the Industry Assistance Act is over, some tariff protection could be given which would permit a little higher price if deemed necessary;

Dextrose. There are no existing price criteria for dextrose. It would be wrong to relate the value of refined dextrose to the value of refined sugar to the same degree as the price relationship exists in most developed countries where dextrose is used in substantial amounts. Cane sugar is priced in the Sudan at around L\$ 148.2 delivered factory, which is equivalent to about \$428 per metric ton. In the assumption made in this report the price of dextrose was projected closer to the glucose value.

While the revenue projection was based upon the same price over a ten year period, it is obvious that some adjustment can be made either way, depending upon circumstances, after the plant has had the experience of sales and the level of volume has been established, as well as the need of revenue to rationalize the operation.

Starch. The assumed price of Sudanese L\$ 60 per metric ton is slightly above the existing cost of common starch in the Sudan. This price is an average and assumes exemption from some duty such as the textile industry now enjoys as an approved industry. The average cost to the textile plant in the Sudan is a composite of starch formulae using modified starch with the common starches and is higher. The degree to which a wet milling plant can satisfy some of the need for modified starch is not apparent to us at this point.

Table IX illustrates the varying prices of starch. For example, in 1964 the average value per metric ton varied from L\$ 39 Sudanese pounds for starch from Poland to L\$ 111 Sudanese pounds for starch from Germany. Even greater variations are noted in prior years. Since these starches are normally not used per se but are blended into a formula, it is extremely difficult to be exact on the price of starch in the Sudan and much will depend upon the degree to which the plant can satisfy the technical requirements. It will be noted that the variations in the prices for glucose are much more confined.

For comparison cane sugar cost L\$ 148.2 delivered factory = \$428.30 per metric ton.

TABLE IX

IMPORT VALUES OF GLUCOSE AND STARCH IN THE SUDAN
1960 to 1964
(Sudanese Pounds)

Product and Source	(Per Metric Tons)				
	1960	1961	1962	1963	1964
<u>GLUCOSE</u>					
Belgium	38.2	-----	-----	50.3	51.4
France	-----	-----	-----	-----	51.2
Germany F.R.	45.7	45.0	45.6	39.9	49.1
Poland	-----	-----	41.4	41.6	47.0
Netherlands	355.2	265.6	144.0	-----	46.9
Sweden	416.8	-----	-----	-----	-----
United Kingdom	212.7	85.8	253.2	75.0	55.9
Yugoslavia	40.9	41.4	41.8	46.8	47.6
Italy	-----	-----	-----	-----	-----
U.S. Africa	56.6	-----	-----	-----	-----
China, P.R.	41.3	-----	-----	-----	-----
Japan	-----	193.6	-----	-----	-----
Total -	46.2	48.7	47.5	42.6	49.8
<u>STARCH</u>					
Belgium	33.0	-----	45.0	35.5	41.9
Greece	-----	-----	-----	-----	-----
Germany F.R.	94.8	109.5	111.0	-----	111.0
U.A.R.	-----	-----	67.0	-----	-----
Netherlands	56.0	55.1	43.6	63.7	-----
Switzerland	-----	-----	-----	-----	40.4
Yugoslavia	38.0	38.0	38.0	-----	-----
Italy	-----	-----	-----	234.0	-----
United Kingdom	63.3	46.3	44.0	71.0	54.9
Poland	-----	-----	-----	37.2	39.0
Total -	84.4	66.0	55.5	40.4	61.8

Source: The Republic of the Sudan - Annual Foreign Trade Reports,
 Department of Statistics, Headquarters Council of Ministers.

4. Estimated Potential Income

The following series of tables are largely self-explanatory. A brief comment regarding each table will suffice.

Table X - This table reflects total revenue expected from the sale of all products over a ten year period. It is interesting to note that the inclusion of dextrose adds significantly to the revenue and in fact more than doubles the volume assumed in our February report.

Table XI - This table was included to illustrate that modification in the price of dextrose somewhat closer to glucose values would not materially alter our conclusions. Dextrose was the only commodity for which we had no existing price criteria to work from.

Table XII - This table summarizes projected earnings on the basis of rough calculations for each year.

Tables XIII through XXIII reflect the calculations on which the projected earnings were based.

TABLE X**PROJECTED POTENTIAL REVENUE FROM SALE OF ALL PRODUCTS ^{1/}**

Year	Starch	Glucose	Dextrose	Oil	Feed	Total
1968	\$ 111,149.40	\$ 654,203.52	\$ 289,000.00	\$ 32,094.26	\$ 86,654.51	\$ 1,173,102
1969	118,258.80	693,415.04	578,000.00	40,783.68	110,115.94	1,540,574
1970	125,715.00	735,031.04	751,400.00	46,697.31	126,082.75	1,784,926
1971	133,171.20	779,051.52	924,800.00	52,677.53	142,229.33	2,031,930
1972	141,147.60	825,846.40	1,098,820.00	58,765.95	158,668.08	2,283,248
1973	149,644.20	874,860.80	1,271,160.00	64,941.77	175,342.77	2,535,950
1974	158,661.00	927,389.44	1,445,000.00	71,259.08	192,399.50	2,794,709
1975	168,198.00	983,062.40	1,445,000.00	73,377.33	198,118.80	2,867,757
1976	178,602.00	1,042,064.64	1,445,000.00	75,637.08	204,220.12	2,945,524
1977	189,352.80	1,104,581.12	1,445,000.00	70,030.00	210,681.00	3,027,645
1978	200,797.20	1,170,796.80	1,445,000.00	80,056.44	217,523.91	3,114,174

^{1/} The above estimates are computed by using the projected sales for the period as given in Table I and by using the following average price assumptions:

Prices Per Metric Ton L£ = \$2.89

	<u>L£</u>	<u>U.S. Dollars</u>
Starch	60	\$ 173.40
Glucose	64	184.96
Dextrose	100	289.00
Oil	80	231.20
Feed	9	26.00

TABLE XI

LOSS IN REVENUE FOR EACH 10 L\$ PER METRIC
TON REDUCTION IN THE PRICE OF DEXTROSE

<u>Year</u>	<u>Total Revenue at Assumed Prices</u>	<u>Loss by Reduction in Price of Dextrose</u>	<u>Corrected Revenue</u>	<u>% Loss in Total Revenue</u>
1968	\$ 1,173,102	\$ 28,900	\$ 1,144,202	2.46
1969	1,540,574	57,800	1,482,774	3.75
1970	1,784,926	75,140	1,709,786	4.20
1971	2,031,930	92,480	1,939,450	4.55
1972	2,283,248	109,882	2,173,366	4.81
1973	2,535,950	127,116	2,408,834	5.01
1974	2,794,709	144,500	2,650,209	5.17
1975	2,867,757	144,500	2,723,257	5.03
1976	2,945,524	144,500	2,801,024	4.90
1977	3,027,645	144,500	2,883,145	4.77
1978	3,114,174	144,500	2,969,674	4.64

TABLE XII

Year	% Operation		Projected Earnings (after depreciation and interest)
	16 Hr.	24 Hr.	
1968	56%		\$ 209,375
1969	71%		446,333
1970	81%		601,509
1971	92%		760,419
1972		68%	931,066
1973		75%	1,092,225
1974		83%	1,255,124
1975		85%	1,294,168
1976		88%	1,340,712
1977		91%	1,389,771
1978		93%	1,441,332
	100%	100%	1,608,888

TABLE XIII

PROJECTED SALES REVENUE, COST AND PROFITS BEFORE
TAXES - 1968

7/8 Operation - 56% basis 16 Hrs/day

Net Sales ----- \$ 1,173,102

Cost of Production

Dura	\$ 250,640	
Supplies	192,800	
Direct Labor	49,286	(66%)
Manf. Overhead	<u>78,550</u>	
	\$ 571,276	----- <u>571,276</u>

Net earnings before depreciation, taxes and interest ----- \$ 601,826

Depreciation ----- 224,200

\$ 377,626

Interest - 5½% - \$3,059,115 ----- 168,251

\$ 209,375

Tax free allowance

TABLE XIV1969

% Operation - 71% Basis 16 Hr/day

Net Sales ----- \$ 1,540,574

Cost of Production

Dura	\$ 318,500	
Supplies	245,000	
Direct Labor	59,740	(80%)
Manf. Overhead	<u>78,550</u>	
	701,790	-----
		<u>701,790</u>

Net earnings before depreciation, taxes and interest -----	\$ 838,784
Depreciation -----	<u>224,200</u>
	\$ 614,584.
Interest - 5½% \$3,059,115 -----	<u>168,251</u>
	\$ 446,333

TABLE XV1970

% Operation - 81% basis 16 Hr/day

Net Sales----- \$ 1,784,926Cost of Production

Dura	\$364,683	
Supplies	280,525	
Direct Labor	67,208 (90%)	
Manf. Overhead	<u>78,550</u>	
	790,966	----- 790,966
Net earnings before depreciation, taxes and interest		----- 1,993,960
Depreciation		----- 224,200
		----- \$ 769,760
Interest 5½% - \$3,059,115		----- 168,251
		----- \$ 601,509

TABLE XVI1971

% Operation - 92% basis 16 Hr/day

Net Sales -----		\$2,031,930
<u>Cost of Production</u>		
Dura	411,385	
Supplies	316,450	
Direct labor	74,675	
Manf. Overhead	<u>78,550</u>	
	881,060 -----	881,060
Net earnings before depreciation, taxes and interest -----		\$1,150,870
Depreciation -----		<u>224,200</u>
		928,670
Interest 5½% - \$3,059,115 -----		<u>168,251</u>
		\$ 760,419*

TABLE XVII1972

% Operation - 68% basis 24 Hr/day

Net Sales -----		\$ 2,283,248
<u>Cost of Production</u>		
Dura	458,933	
Supplies	353,025	
Direct labor	69,223 (78%)	
Manf. Overhead	<u>78,550</u>	
	959,731 -----	<u>959,731</u>
Net earnings before depreciation, taxes and interest -----		<u>1,323,517</u>
Depreciation -----		<u>224,200</u>
		\$1,099,317
Interest 5½% - \$3,059,115 -----		<u>168,251</u>
		\$ 931,066

TABLE XVIII1973

75% Operation - 75% basis 24 hr/day

Net Sales -----		\$ 2,535,950
<u>Cost of Production</u>		
Dura	507,163	
Supplies	390,125	
Direct Labor	75,436 (85%)	
Manf. Overhead	<u>78,550</u>	
	\$1,051,274-----	<u>1,051,274</u>
Net earnings before depreciation, taxes, interest -----		\$1,484,676
Depreciation -----		<u>224,200</u>
		\$1,260,476
Interest 5½% - \$3,059,115 -----		<u>168,251</u>
		\$1,092,225

TABLE XIX1974

% Operation - 83% basis 24/day

Net Sales -----		\$ 2,794,709
<u>Cost of Production</u>		
Dura	\$556,498	
Supplies	427,775	
Direct Labor	84,311 (95%)	
Manf. Overhead	<u>78,550</u>	
	1,147,134 -----	<u>1,147,134</u>
Net earnings before depreciation, taxes, interest -----		\$ 1,647,575
Depreciation -----		<u>224,200</u>
		\$ 1,423,375
Interest 5½% - \$3,059,115 -----		<u>168,251</u>
		\$ 1,255,124

TABLE XX1975

% Operation - 85% basis 24 hr/day

Net Sales -----		\$ 2,867,757
<u>Cost of Production</u>		
Dura	\$ 573,040	
Supplies	440,800	
Direct Labor	88,748 (100%)	
Manf. Overhead	<u>78,550</u>	
	1,181,138 -----	<u>1,181,138</u>
Net earnings before depreciation, taxes, interest -----		\$ 1,686,619
Depreciation -----		<u>224,200</u>
		\$ 1,462,419
Interest 5½% - \$3,059,115 -----		<u>168,251</u>
		\$ 1,294,168

TABLE XXI1976

% Operation - 88% basis 24 hr/day

Net Sales -----		\$ 2,945,524
 <u>Cost of Production</u>		
Dura	\$ 590,688	
Supplies	454,375	
Direct labor	88,748	
Manf. Overhead	<u>78,550</u>	
	\$1,212,361 -----	· 1,212,361
Net earnings before depreciation, taxes, interest -----		\$ 1,733,163
Depreciation -----		<u>224,200</u>
		\$ 1,508,963
Interest 5½% - \$3,059,115 -----		<u>168,251</u>
		\$1,340,712

TABLE XXII1977

% Operation - 91% basis 24 hr/day

Net Sales -----\$ 3,027,645

Cost of Production

Dura	\$ 609,375	
Supplies	468,750	
Direct Labor	88,748	
Manf. Overhead	<u>78,550</u>	
	\$ 1,245,423	----- 1,245,423
Net earnings before depreciation, taxes, interest		----- \$1,782,222
Depreciation		----- <u>224,200</u>
		\$1,558,022
Interest 5½% - \$3,059,115		----- <u>168,251</u>
		\$ 1,389,771

TABLE XXIII1978

% Operation - 93% basis 24 hr/day

Net Sales -----		\$ 3,114,174
<u>Cost of Production</u>		
Dura	629,168	
Supplies	483,925	
Direct Labor	88,748	
Manf. Overhead	<u>78,550</u>	
	\$1,280,391 -----	<u>1,280,391</u>
Net earnings before depreciation, taxes, interest -----		\$ 1,833,783
Depreciation -----		<u>224,200</u>
		\$ 1,609,583
Interest 5½% - \$3,059,115 -----		<u>168,251</u>
		\$ 1,441,332

Basis 100% Operation

Net Sales -----		\$ 3,348,575
<u>Cost of Production</u>		
Dura	670,313	
Supplies	515,825	
Direct Labor	88,748	
Manf. Overhead	<u>78,550</u>	
	\$1,353,236 -----	<u>1,353,236</u>
Net earnings before depreciation, taxes, interest -----		\$ 1,995,339
Depreciation -----		<u>224,200</u>
		\$1,771,139
Interest -----		<u>168,251</u>
		\$ 1,608,888