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D02973

Distribution:
LIMITED

ID/WG.99/107
26 November 1971

United Nations Industrial Development Organization

Original: ENGLISH

Second Interregional Fertilizer Symposium

Kiev, USSR, 21 September - 1 October 1971
New Delhi, India, 2 - 13 October 1971

Agenda item II/18

THE FERTILIZER INDUSTRY OF SUDAN[1/]

by

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Sudan

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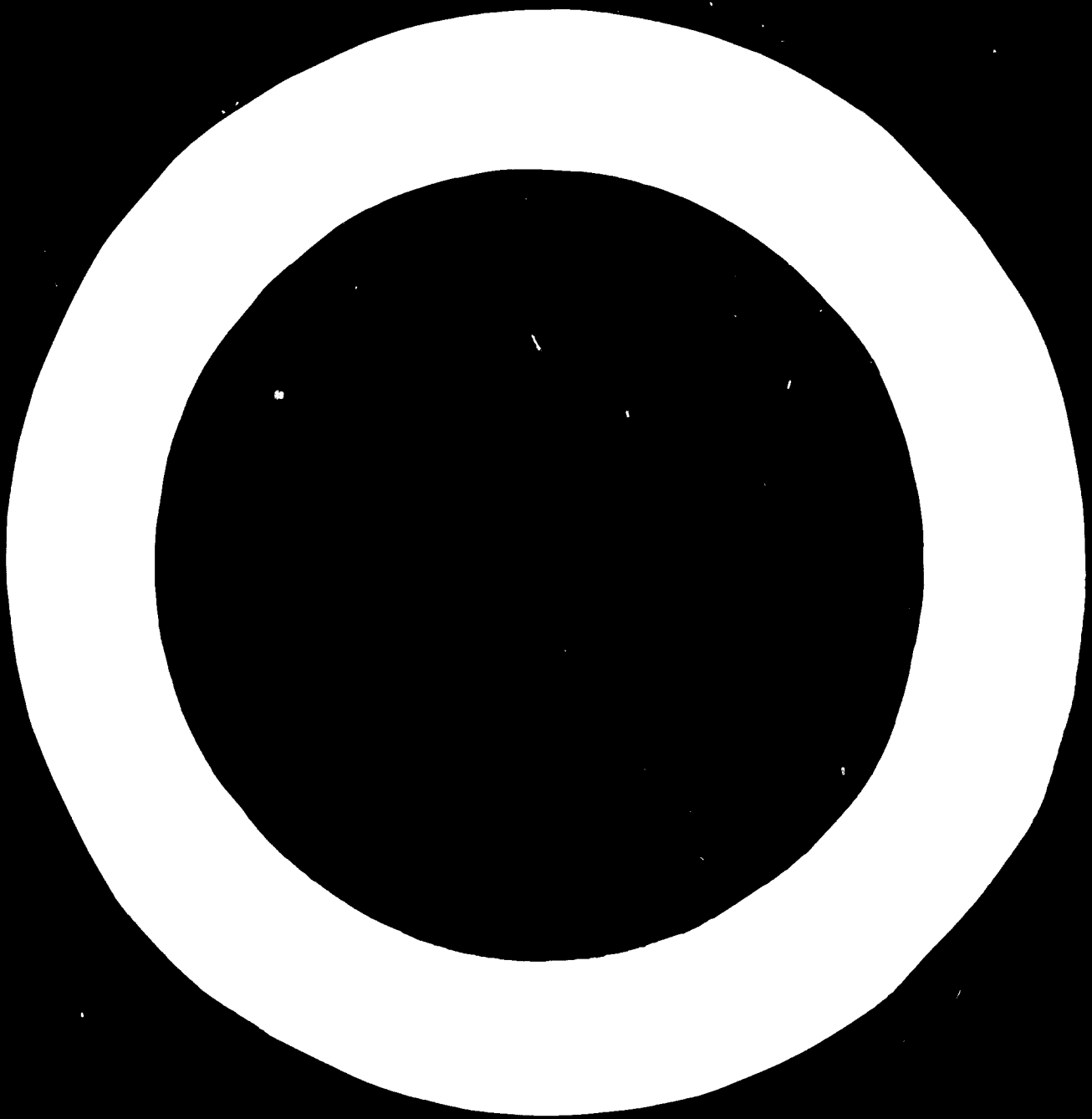

The Sudan is primarily an agricultural country with vast areas of good agricultural land, adequate water resources and favourable climate for the production of various types of food and cash crops under both irrigation and rain-fed cultivation. The Sudan has therefore depended on agricultural products as the main source of food, foreign exchange, and the main parts of the gross national product. Of the 100 million acres of potential cultivable land, only about 9.5 million acres are cultivated at present 2.2 millions under irrigation and 7.3 millions of rain lands.

The main crops grown in the Sudan, the areas grown of each and the estimated average yields per acre are listed in table 2. Cotton is the main and most important cash crop of the Sudan and Dura (Sorghum) is the staple food of the great majority of the people. Export commodities are mostly agricultural products with cotton occupying a leading position (57.7 %), sesame seeds (9.1 %), gum Arabic (7.6 %), groundnuts (7.5 %), and oil cakes (6 %), vegetable oil (1.1 %) and castor seed (0.8 %). At present the economy is mainly based on the export of cotton.

The increase in agricultural production in the Sudan has mainly been achieved through the expansion in cropped areas. In the last decade over 0.7 of a million areas of irrigated land and about 1.2 million acres of rainlands were developed. However, the increases in the yields per acre of the various crops have been very limited. The present five-year plan of economic and social development of the Sudan (1970-1975) aims at developing agricultural production both horizontally and vertically. It has been realized that the maximum possible intensification of cropping and the

Table 1. Areas and average yields of the main crops of the Sudan

Crop	Area in thousand acres	Yield *
Long Staple Cotton	787	4.8
Sudan Staple Cotton	364	5.3
Short Staple Cotton	545	1.0
Groundnuts	939	0.40
Dura (Sorghum)	3,648	0.35
Wheat	314	0.50
Sesame	1302	0.15
Gum Arabic	48	27
Millet	1458	0.26
Simsim	126	0.70
Castor	45	0.45

* Yields given in kantars (315 lb. seed cotton) per acre for cotton and in tons for all other crops.

Increase in yield per unit area are among the most import means of increasing production. To achieve this the use of artificial fertilisers is recognised as one of the essential elements of advanced crop husbandry. The importance of artificial fertilization of crops stems therefore from the need for vertical development of agricultural production.

The response of crops to the application of fertilizers has been studied extensively in the Sudan. In these studies, nitrogenous fertilizers were of the greatest attention, as most of the soils have for long been known to be inherently low in nitrogen. Among the aspects studied were the effects of the types, amount, method and time of applying nitrogen on the yield and growth of crops.

The effects of nitrogen, phosphate and potash (NPK) on cotton yield have been investigated using data obtained over a period of 18 years (Burhan and Mansi, 1969). The response of cotton to nitrogen was significant and fairly consistent but the rate of increase in yield with increased N diminished gradually. The response to [illegible] and that to P negligible. Similar investigations were conducted on various other crops.

Fertiliser nitrogen has been shown to result in substantial increases in the yield of crops. At present, nitrogen is practically the only fertiliser element used commercially for crops in the Sudan. Nitrogen fertilisers constitute more than 97 % of the total imports of artificial fertilisers. Urea (46 % N) is the fertiliser most widely used in the Sudan. It is mostly applied to irrigated crops particularly cotton, wheat, sugar cane, vegetables and very recently dura. Limited amounts of fertiliser are used in the rain cultivated areas and hardly any in flood-irrigation schemes.

The price of urea has been showing a tendency to decrease, as illustrated by the purchases of the Sudan Gezira Board, the biggest user of fertiliser nitrogen in the Sudan (Table 2).

The rate of fertiliser application per unit area has been increasing gradually over the years. Most recently the recommended dose for wheat in the Gezira area of the Sudan was increased from 40 to 80 lb.N/acre. Evidence was also presented to indicate that the present rate of fertilizer application to cotton in the Gezira (80 lb N per acre) is below the optimum economic level and that the application of 120 lb N per acre would be economic. Large scale trials are therefore being conducted on increased fertilizer rates.

In addition to the development of new agricultural areas and the increase in dosage rates, fertiliser use is also increasing in privately owned farms on various crops which have not been receiving any type of chemical fertilization. There are therefore reasons to believe that the Sudan's demand for fertiliser

Table 2. Prices of urea as [illegible] the products of the Sudan Gezira board [illegible]

Year	Quantity in M. Tons	Prices Fe[illegible] Ton C.i.f	Origin
1955/56	18,000	£[illegible]	Italy
1960/61	27,000	£[illegible]	Norway, Japan, Italy.
1961/62	36,620	£29 - 11 - 0d	W. Germany, Holland, Norway, Italy, Japan.
1962/63	23,000	£[illegible]	Japan, Italy, W. Germ[illegible]
1963/64	43,775	£29 - 15 - 0d	Belgium, Japan, Sweden, Italy, Pakistan.
1964/65	[illegible]	£[illegible]	Italy, Holland, Norway, Belgium, Japan.
1965/66	44,000	£[illegible]	W. Germany, Belgium, Italy, Norway, U.S.A.
1966/67	45,500	£[illegible]	Japan, U.S.A.
1967/68	54,677	£[illegible]	U.S.S.R., Roumania, Japan.
1968/69	53,[illegible]00	£[illegible]	France, Norway, Netherland
1969/70	53,[illegible]00	£[illegible]	U.S.S.R., Roumania.
1970/71	72,000	£[illegible]	U.S.S.R., Poland

nitrogen will continue to increase during the coming several years. This is clearly reflected in the estimated requirement of fertilizer nitrogen, calculated by the Ministry of Planning for the Five-years plan, given in table 3. The total annual requirement which was in the neighbourhood of 100 thousand tons of urea in 1970 is expected to rise to about 200 thousand tons in the next few years. It is important to realise that it has been rather difficult to assume that all the estimated amount will be consumed, particularly in the rainlands and privately owned farms where the percentage of land which will be fertilized is hard to predict. The amounts estimated for government schemes are fairly reliable. The estimated increase in expenditure on fertilisers and its percentage of the total imports of the Sudan, as indicated by the pattern of import commodities, are given in table 4.

Nitrogenous fertilisers have consistently been among the commodities imported by the Sudan. No fertiliser industry has as yet been established in the country. However, realising that the demand for nitrogenous fertiliser is sufficiently high, the importance of the construction of a fertiliser factory has been stressed upon several occasions.

The feasibility of establishing a fertiliser factory in the Sudan was first studied by the Batelle Institute - Frankfurt am Main in 1963 and by the Shell International Company in 1964. More recently, 1968, the Sudan Industrial Research Institute prepared a comprhensive study entitled "The Feasibility of Setting Up a Nitrogen Fertiliser Plant in the Sudan;" the salient features of which are summaried in the following four paragraphs.

The original report was based on an annual capacity of 100 thousand metric tons of urea which was soon realised to be insuffient for the future needs of the country and an addendum was prepared including an economic study of the project based on a capacity of 170 thousand tons of

Table 3. Estimated requirements of nitrogen fertilizer as calculated for the Five-Year Plan by the Ministry of Planning

Crops	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1974/75 as against 1969/70 in (%)
1. Cotton:							
a) Area Fertilized	951.0	1041.0	1146.0	1252.0	1352.0	[illegible]	[illegible]
b) N dose	27.6	34.72	37.67	40.57	44.34	[illegible]	[illegible]
c) Requirement in Standard (20.5% N)	-	176.0	210.0	250.0	292.0	[illegible]	-
d) Same in Urea (46.1 % N)	56.62	78.0	93.0	[illegible]	128.6	[illegible]	225.9
2. Wheat:							
a) Area Fertilized	277.0	370.0	433.0	[illegible]	[illegible]	[illegible]	[illegible]
b) N dose	8.0	8.0	8.0	[illegible]	[illegible]	[illegible]	[illegible]
c) Requirement in Standard (20.5% N)	-	14.4	16.8	[illegible]	[illegible]	[illegible]	[illegible]
d) Same in Urea (46.1 % N)	4.7	6.3	7.3	[illegible]	[illegible]	[illegible]	[illegible]
3. Vegetables, Melons and Potato:							
a) Area Fertilized	150.0	150.0	160.0	170.0	180.0	[illegible]	133.3
b) N dose	17.44	17.44	17.44	17.44	17.44	[illegible]	[illegible]
c) Requirement in Standard (20.5% N)	-	12.75	13.6	14.85	15.7	17.0	-
d) Same in Urea (46.1 % N)	5.6	5.8	6.0	6.4	6.8	7.[illegible]	133.3

• Units for above table are:

Area in thousand acres, N dose in kg./acre and requirement in thousand tons.

1	2	3	4	5	6	7	8
4. Dura:							
(i) In irrigated lands							
a) Area Fertilized	500.0	500.0	500.0	500.0	500.0	500.0	100.0
b) N dose	9.0	16.0	16.0	16.0	16.0	16.0	177.7
c) Requirement in Standard (20.5 % N)	-	39.0	39.0	39.0	39.0	39.0	-
d) Same in Urea (46.1 N)	9.6	17.2	17.2	17.2	17.2	17.2	177.7
(ii) In Rainlands							
a) Area Fertilized	100.0	1000.0	1500.0	1500.0	1500.0	1500.0	150.0
b) N dose	8.0	8.0	8.0	8.0	8.0	8.0	100.0
c) Requirement in Standard (20.5%N)	39.0	39.0	58.5	58.5	58.5	58.5	-
d) Same in Urea (46.1 % N)	17.2	17.2	25.8	25.8	25.8	25.8	150.0
5. Crops, the rest							
a) Requirement in Standard (20.5 % N)	45.0	45.0	45.0	45.0	45.0	45.0	100.0
d) Same in Urea (46.1 % N)	20.0	20.0	20.0	20.0	20.0	20.0	100.0
Total Requirement in Standard(20.5 % N)		325.0	384.9	442.3	445.3	495.1	569.2
Same in Urea (46.1 % N)	113.7	144.3	169.5	196.5	219.2	249.6	219.5

Table 4. Estimated expenditure on fertilizers and percentage of the total imports for the years 1965 - 1975

Year	Amount in L.S. Millions	% of total imports	
1965	1.9	2.6	Actual
1966	2.2	2.7	"
1967	2.1	2.5	"
1968	0.94	1.0	"
1969	1.4	1.5	"
1970	2.0	1.9	Estimated
1971	2.7	2.4	"
1972	3.5	2.9	"
1973	4.2	3.1	"
1974	5.0	3.4	"
1975	5.8	3.6	"

urea per year. It is relevant to mention that since the preparation of that report several discussions have been made in meetings pertinent to the project, and with delegations concerned with the fertilizer industry. It is now generally accepted that a capacity of 200 thousand tons of urea would be more appropriate.

In selecting one of the processes known in the production of synthesis gases, the initial step to ammonia and then urea synthesis, the report recommended the steam reforming of naphtha. Steam reforming of natural or refinery gases was not considered as there is no natural source of gas in the Sudan and the supply of refinery gases is insufficient. The naphtha process was reported more economic than the partial oxidation of fuel oil and the process of electrolytic production of hydrogen in combination with partial oxidation of fuel oil was considered economically feasible only in

the vicinity of an extremely cheap source of hydro-electric power which cannot be used more economically. For ammonia synthesis, due to the small production capacity, the process using reciprocating compressors was considered inevitable. The total recycle process was chosen for urea synthesis by the reaction of ammonia and its by-product carbon dioxide.

The report compared various alternative sites including Port Sudan, Sennar, Khartoum and Roseires areas. Port Sudan, where the Shell refinery can be used as a source of the raw material light naphtha and where transportation costs are lowest, has the major disadvantages of acute shortage of fresh water, needed in big quantities for the factory, and the high cost of electrical power. An economic evaluation of the different localities taking into account the main items of cost (transport of equipment, naphtha, fuel, oil and fertilizer; cost of electricity, water, and extra civil engineering) indicated that the most suitable plant site seems to be Sennar. Located on the Blue Nile and the junction of several railway lines, Sennar has the advantages of being in the centre of the main agricultural area, adequate fresh water, and fairly cheap hydro-electric power.

The total captial cost of a plant producing one hundred thousand tons of urea was estimated at about twenty and a half million dollars, 72 % of which is in foreign currency. The economics of the project taking into account fixed, variable and total cost, revenue and profitability were calculated at various levels of production for the two plant capacities proposed then. The main items of the calculation of the annual profits and foreign exchange savings are presented in table 5.

Table [illegible]. Profitability and foreign exchange savings for two capacities of the fertilizer urea plant

	For capacity of 100,000 tons (£ millions)	For capacity of 170,000 tons (£ millions)
Annual revenue * (Sales)	8.0	13.60
Annual operating costs °	3.7	9.99
Annual Profit	4.3	3.61
Cost if imported urea	7.4	12.6
Total foreign exchange expenditure including (depreciation, interest, naphtha, fuel).	4.0	5.9
Annual net foreign exchange saving.	3.4	6.7

* Assuming an average price of $74 per ton of urea (CIF Port Sudan) and £S0 at Sennar.
° Annual operating costs include 4% interest on fixed capital.

It is evident that the establishment of a nitrogen fertilizer plant in the Sudan is a profitable as well as a foreign exchange saving proposition. Several hundred people are also expected to earn living from employment by the factory. Furthermore, the availability of fertilizer in the country, in addition to satisfying the country's needs, is apt to encourage fertilizer use and promote its role in agricultural production.

In providing for further development of industrial production and the introduction of new types of industrial products to meet domestic requirements and reduce imports of various commodities, the Five Year Plan for Economic and Social Development of the Sudan (1970/75) envisages the construction of a fertilizer plant at Sennar to produce 200 thousand tons of urea annually.

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