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International Fertilizer Development Center

Volume I–Regional Overview
Volume II–Senegal
Volume III–Mali
Volume IV–Upper Volta
Volume V–Niger
Volume VI–Chad
Volume VII–Mauritania

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER
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PREFACE

A series of severe droughts in the late 1960's and early 1970's greatly reduced agricultural production in the Sahelian countries of west Africa. The human suffering during that time led to an international focus on the region in terms of food aid and development assistance.

The U.S. Agency for International Development (USAID) was aware of the contribution of fertilizers to food production and the limited fertilizer use in this region. Thus, USAID requested the International Fertilizer Development Center to determine the current capacity and potential of the Sahelian region to produce, market, and use fertilizers. This series of documents is a result of that assessment. Published and unpublished literature was obtained in each country and from international development agencies. Field level interviews were also conducted.

Principal team members were Ray B. Diamond (team leader), Donald R Waggoner, and Kham Thanh Pham from IFDC along with Hans Braun on loan from FAO. Many other members of the IFDC staff contributed greatly to the report. Bernard Raistrick (consultant from the United Kingdom) and Travis P. Hignett (consultant from the United States) assisted in preliminary collection and analysis of data before the field visits. Josiah Royce (USAID, REDSO/WA) assisted in data gathering during field visits. Appreciation is expressed to representatives of national agencies, USAID, and other international organizations for assistance.

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ABBREVIATIONS USED IN THIS REPORT

FERTILIZERS

N . . . . . Nitrogen
P . . . . . Phosphorus
P_2O_5 . . . . . Phosphate
K . . . . . Potassium
K_2O . . . . . Potash
B . . . . . Boron
B_2O_3 . . . . . Borate
Ca . . . . . Calcium
S . . . . . Sulfur

Fertilizer Formula–% of N-P_2O_5-K_2O by Weight

AS . . . . . Ammonium Sulfate (21-0-0)
DAP . . . . . Diammonium Phosphate (18-46-0)
KCl . . . . . Potassium Chloride (0-0-60)
KS . . . . . Potassium Sulfate (0-0-50)
PR . . . . . Phosphate Rock
SSP . . . . . Single Superphosphate (0-20-0)
TSP . . . . . Triple Superphosphate (0-45-0)
Urea . . . . . Urea (45-0-0 to 46-0-0)

MEASURES

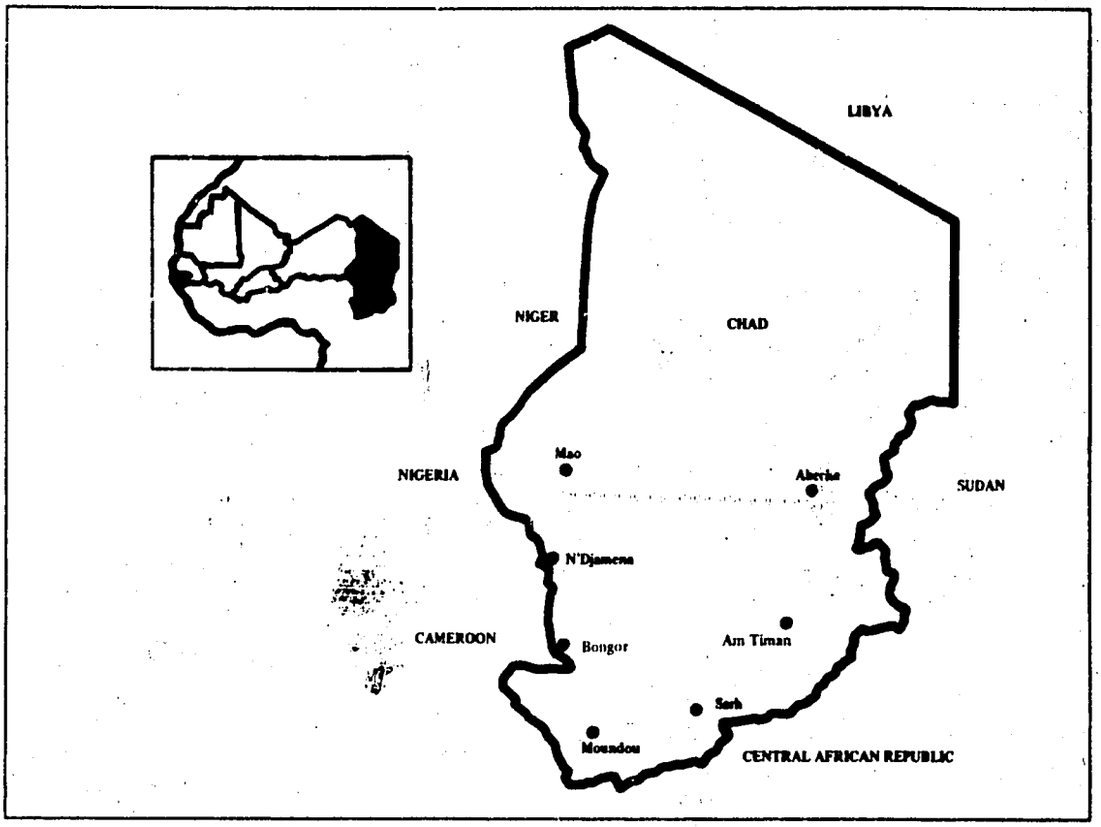
ha . . . . . hectare (2.47 acres)
kg . . . . . kilogram (1 pound = 0.454 kg)
km . . . . . kilometer (1 mile = 1.61 km)
m . . . . . meter (1 yard = 0.91 m)
mm . . . . . millimeter (1 inch = 25.4 mm)
l . . . . . liter (1 gallon = 3.785 l)
mt . . . . . metric ton (2,204 pounds = 1,000 kg)
% . . . . . percent
tpy . . . . . tons per year

ECONOMIC AND MONETARY

c.i.f. . . . . cost, insurance, and freight
F CFA . . . . . CFA Franc, currency of the West African Monetary Union (Communante Financiere Africaine Franc = US $1 = 225 F CFA
f.o.b. . . . . free on board
GDP . . . . . gross domestic product
ROI . . . . . return on investment
WC . . . . . working capital

GOVERNMENTAL AND INTERNATIONAL AGENCIES

BDT . . . . . Chad Development Bank
BET . . . . . Borkou-Ennedi-Tibesti prefecture
CIDA . . . Canadian International Development Association
COTONTCHAD . . . . . Chad Cotton Company
CSPC . . . . . Cotton Price Stabilization Fund
FAC . Development Aid Agency of the French Government (Fonds d'Aide et de Cooperation)
FAO . . . . . Food and Agriculture Organization
FDAR . . . . . Rural Development and Activities Fund
FED . . . . . European Development Fund
GOC . . . . . Government of Chad
GR . . . . . Rural Engineering Service
IBRD . . . . . International Bank for Reconstruction and Development
IFDC . . . . . International Fertilizer Development Center
IFS . . . . . International Fertilizer Supply Scheme
IRCT . . French Research Institute for Cotton and Textiles
MEAE . . . . . State Ministry in Charge of Agriculture and Livestock Production
MEPCCI . . . . . State Ministry in Charge of Economy, Planning, Trade, and International Cooperation
MTPAT . . . . . Ministry of Public Works and Land Improvement
OMVSD . . . . . Bureau for the Development of the Sategui-Deressia Area
ONDR . . . . . National Bureau for Rural Development
PPT . . . . . Parti Progressiste Tchadien
SAFGRAD . . . . . Semi-Arid Food Grain Research and Development
SCPA . . . . . Commercial Nitrogen and Alsatian Potash Company
SEMA . . . . . Experimental Sectors for Agricultural Modernization
SEMAB . . . . . Experimental Sectors for Agricultural Modernization (in the rice-producing areas of Bongor)
SEMALK . . . . . Experimental Sectors for Agricultural Modernization (in Lai-Kelo area)
SEMAMK . . . . . Experimental Sectors for Agricultural Modernization (in the Mayo-Kebbi district)
SEPCAE . . . . . Fertilizer and Chemical Products Company of Equatorial Africa
SIES . . . . . Industrial Fertilizer Company of Senegal
SOCAME . . . . . Cameroon Fertilizer Company
SODELAC . . . . . Lake Chad Development Corporation
SONACOT . . . . . A marketing organization for various products other than wheat and millet
TVA . . . . . Tennessee Valley Authority
UNDP . . . . . United Nations Development Program
USAID . . . . . United States Agency for International Development



SUMMARY OF FINDINGS

1. The series of droughts in the late 1960's and early 1970's drastically reduced cereal production in Chad.

2. Apparent per capita supply of cereals dropped from 184 kg/person in 1970/71 to 161 kg/person in 1974, while imports increased from 10,000 mt to 81,000 mt.

3. Average cereal demand is projected to increase by 21,000 mt/year between 1975 and 1985. Increased urban demand will account for about 35% of the increases between 1975 and 1980 and 43% between 1980 and 1985.

4. Potential deficit of cereal could reach 350,000 mt in 1980 and 455,000 mt in 1985 if production is not increased above apparent production in 1975.

5. Some constraints on agricultural production are low levels of fertilizer use, mechanization, improved seed and other improved technology; fluctuating crop prices; generally unfavorable fertilizer/crop prices; inadequate extension advisory service; and insufficient use of credit.

6. Except for cotton, very little agronomic research has been done on experimental stations or on

farmers' fields; much more is needed.

7. Estimated fertilizer nutrient consumption in 1975 is 6,000 mt and projected to reach about 11,000 mt and 15,000 mt in 1980 and 1985, respectively.

8. Assuming a grain response of 10 kg/kg of nutrient, the use of imported fertilizer for cereals versus importing cereals can save Chad 4.4 F CFA in foreign exchange for each F CFA in foreign exchange spent for fertilizer. That is, 1,000 mt of fertilizer nutrients costing 125 million F CFA would yield 10,000 mt of grain valued at 550 million F CFA (each delivered to N'Djamena).

9. Although the transportation is generally viewed as inadequate due to poor, insufficiently maintained roads and seasonal variations of water transport, the network appears sufficiently extensive to access most populous areas. But improved or new roads are likely needed in new production areas.

10. Phosphate deposits in Chad have not been identified. However, their existence in Bahr-er-Ghazal depression appears to be promising.

11. Trona mineral deposits of about 6.5 million mt are found in depressions near Lake Chad. These are currently mined and used as a substitute for salt for human consumption and as a food supplement for animals.

12. An oil refinery of 2,000 mt/year capacity is now operating using imported oil. A consortium headed by CONOCO has drilled at least two oil-bearing wells.

13. Establishing a bulk-blending plant in Chad, importing fertilizer materials, and blending mixed grades can save more than $3.6 million/year by 1980 in foreign exchange over importing the mixed grades.

RECOMMENDATIONS

1. **Initiate a study of the effect on regional and national economies of public policies for price stabilization and equalization for agricultural inputs and crops.**

2. **Conduct a study to identify ways to improve the system of reporting agricultural statistics.**

3. **Strengthen agricultural research, particularly to determine adapted varieties, define appropriate plant associations and rotations, and solve the symbiotic weed problem in sorghum and millet.**

4. Begin a concentrated soil fertility project in liaison with current research and extension groups designed to obtain relevant information for crop response to fertilizer nutrients on small- and medium-sized farms.

5. Initiate aerial radiometrics study of the Bahr-er-Ghazal area to define areas in which prospecting for phosphate rock would be most promising.

6. Establish a bulk-blending facility based upon a low-technology scheme and imported granular fertilizers.

INTRODUCTION

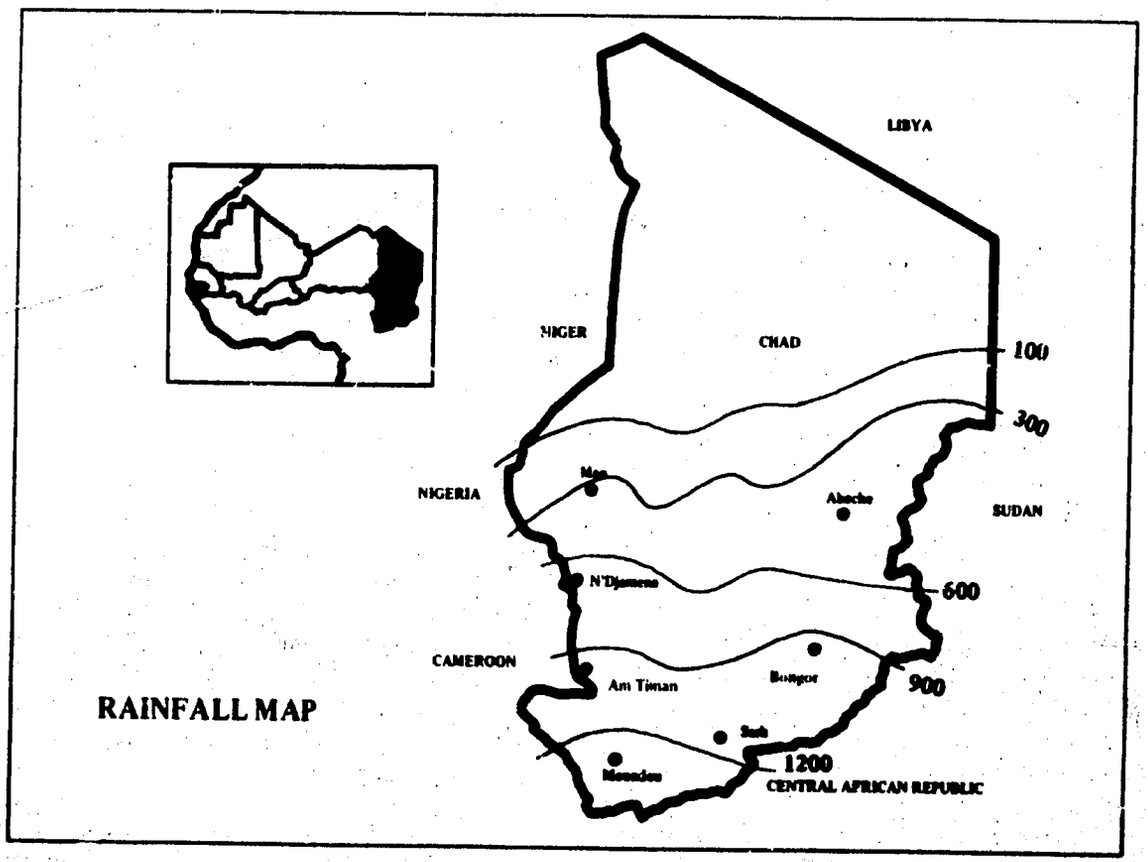
Chad is the only country of the six Sahelian countries which belongs to central Africa. It is located between 8° and 23°N latitude and 14° and 24°E longitude. Total land area is 1,284,000 km^2. The population was estimated at about 4.2 million in 1975. An important geographical characteristic of the country is that it is landlocked; the distance from N'Djamena to seaports varies between 1,100 and 3,000 km.

Physical Characteristics

Topographically, the country is a basin with Lake Chad (elevation 230 m) being the low point. The elevation rises to rolling plateaus (tree savanna) in the south and east and to mountains (about 3,000 m) in the far north (1).

About one-third of the country is situated inside Sudanian savanna lands with the extreme south inside the Guinean ecological zone. The northern borders of these zones are the isohyettes of average annual rainfall of 600 and 1,200 mm, respectively. The main season for rainfed agriculture is about June to October.

Ferrallitic, tropical ferruginous, and reddish-brown soils of arid and semiarid regions are the principal types of soils. Roughly, their locations correspond to the Guinean, Sudanian, and Sahelian zones of vegetation (2). Vertisols are prominent



in western Chad south of the lake and hydromorphic soils exist widely within the zone with tropical ferruginous soils.

Soils in the cotton-growing area were developed on continental terminal and on alluvium (3). The first group consists mainly of slightly ferrallitic red soils on sands and sandstone of the continental terminal. They have a homogeneous profile, and the physical properties are excellent. The structure is fine and developed, providing for good internal drainage, even where clay content exceeds 50%. Potassium and phosphorus reserves are low, although a relatively high fraction of phosphorus is present in available form.

Koros soils are located in the rolling hills situated in the southernmost part of the country and cover two-thirds of the main cotton-growing area. Soil types range with topography--slightly ferrallitic soils on the upper parts, degraded ferrosoils on the slopes, and hydromorphic soils in the valley bottoms generally flooded in the rainy season. These soils are affected by erosion.

Population density is relatively high, which leads to short periods under bush fallow. Inherent soil fertility is poor and exhaustion of soils is widespread (4). The pH values are in the order of 6.0 to 6.5.

The reddish-brown soils of the arid and semiarid regions are generally very sandy. They are generally poor in organic matter but easy to work without machinery. During dry spells, these soils lack water-holding capacity to support plant life. Typical crops are millet and peanuts with sorghum grown on soils with more clay content. Regions where these soils occur are generally marginal for crop production and are mainly used for extensive grazing (5).

The best agricultural soils are located on the northern shores of Lake Chad; on the banks of the Logone River (rice production); and on the Chari River banks (vegetable and projected citrus and sugarcane production). All three areas have possibilities for larger-scale irrigation (4).

Lowland polder areas, reclaimed from Lake Chad, have vertisols of alluvial origin which are highly fertile. At present, they can annually produce, without fertilizer, about 2,500 kg/ha seed cotton and wheat. It is estimated that such production levels can be maintained for another 5-10 years. The prevailing pH values appear to be between 5.5 and 6.0. It is estimated that phosphorus will become the first yield limiting factor. On some wheat, 45 kg of N/ha and 45 kg of P_2O_5/ha are used (7).

Political Characteristics

Chad became independent in 1960. One political party, the Parti Progressiste Tchadien (PPT), dominated politics in Chad from independence until a military takeover in April 1975. The military government suspended the National Assembly and the constitution. General Felix Mallsum is the Head of State.

The financial position of the government in Chad is poor. Its financial resources appear to be insufficient to cover needed planning, implementation, and operation of agricultural development projects. In 1970, the expenditure in agriculture and livestock production amounted to about 5% of the total budget (6).

This shortage of economic development funds is partly caused by the necessity for security spending due to the high amount of internal unrest. Spending for security forces increased from about 18% in 1968 to more than 30% of the total budget throughout the years 1970-72 (8). The current military leadership is actively pursuing a policy of national reconciliation in the hopes of calming the internal unrest.

Cultural Characteristics

Chad can be divided broadly into two cultural regions. Most of the northern portion lies in the Sahara and is sparsely populated by nomadic and semi-nomadic Arab tribes. The southern portion is a savanna area settled by sedentary Bantu tribes, the largest being the Sara group (also the ruling group). One million Sara people are sedentary cultivators. Sudanic groups are in the northern part and are mainly pastoralists. Ethnic groups are: Arab (46% of population), Sudanic Sara (28%), Sudanic Kirdi (5%), Nilotes (9.5%), Saharan cluster (7%), and others (4%) (9).

Economic Characteristics

In 1974, gross domestic product (GDP) totaled $0.3 billion or roughly $80 per capita (11). Chad's economic welfare is derived from its agricultural sector employing most of the country's work force. The commercial economy of Chad is small and weak, with most people living in the subsistence sector. In 1960, about 94% of the population was in agriculture. This had decreased to about 89% in 1970 and 86% in 1975 (10). The population is concentrated in agricultural areas to the south.

Although most Chadians are engaged in subsistence farming, some cotton, gum arabic, and livestock are also produced for commercial purposes. These commodities are responsible for most of Chad's foreign exchange earnings, valued at about $31 million in 1974.

The production of these three commodities is encouraged by the government. A recent productivity campaign by the government and favorable climatic conditions led to an increase in the cotton harvest from 115,000 tons (valued at $25.8 million) in 1974 to over 140,000 tons in 1975. Livestock production is also recovering from the ill effects of the drought. However, it is expected that several more good years will be required to rebuild herds and restore pastures. From 1972-1974, cattle losses ranged from 35 to 95% in the various cattle producing regions. Meat exports and leather and skin exports were valued at $2.9 million and $1.0 million, respectively, in 1973. The output of gum arabic continued to fall in 1974 due to a drought-induced labor shortage in producing areas.

Chad's industrial output is largely dependent on that of the agricultural sector. The main facilities are cotton, gum, and food processing. Although production has been rising in most areas in recent years, growth of the industrial sector is impeded by high transportation costs, small local markets, and a lack of power.

Chadian exports in 1973 equaled only 46% of the value of imports. The trade deficit of $44.2 million stemmed from the increased need for expensive manufactured imports, the rapid price increase of raw material imports such as sugar and petroleum, and the lack of exportable Chadian commodities.

The government is attempting to reduce its dependence on foreign sources for sugar and petroleum supplies, although no development had occurred in these industries in 1976.

The government's primary sources of income are customs and excise tax receipts and special fees for various products. Two products, cotton and meat, account for more than 70% of Chad's annual export earnings. The 1975 national budget was estimated at $90 million, a $10 million increase over the 1974 budget.

POPULATION AND FOOD NEEDS

Population

The total population in 1975 was estimated at 4.2 million and the overall annual growth rate was about 2.9% (table 1). The last population census was taken in 1964 (12). Approximately 50% of the population lives in an area south of the Chari River, accounting for only 15% of Chad's land area (13).

Population density by prefecture (largest administrative unit) is shown in table 2. Logone Occidental had the

Table 1. Estimated Population and Growth Rates in Chad (10)

Section of Population	1970	1975	1980	1985	1990
Total, 1,000 persons	3,640	4,199	4,843	5,577	6,417
Rural, % of total	88.7	86.1	83.3	80.3	77.3
Growth rate preceding 5 years					
Total, %/year		2.9	2.9	2.9	2.8
Rural, %/year		2.3	2.2	2.0	2.1
Urban, %/year		7.2	6.7	6.3	5.8
Growth rate of active population preceding 5 years					
Total, %/year		2.8	2.7	2.6	2.5
Rural, %/year		2.4	2.2	2.0	1.8
Urban, %/year		7.1	6.8	6.4	6.1

Table 2. Estimated Distribution of Population of Chad by Prefecture (13, 14)

Region and Prefectures	Population, 1,000 persons			Density, No./km^2		
	1964	1970	1972	1964	1970	1972
SAHARAN						
Borkou-Ennedi-Tibesti (B.E.T.)[a]	75	81	82	0.1	0.1	0.1
SAHELIAN						
Batha	159	324	335	1.8	3.6	3.8
Biltine	92	141	146	2.0	3.0	3.1
Chari-Baguirmi	214	461	490	2.6	5.6	5.9
Guera	156	174	181	2.7	3.0	3.1
Kanem	170	188	193	1.5	1.6	1.7
Lac	95	127	131	4.3	5.7	5.9
Salamat	66	90	95	1.0	1.4	1.5
SOUTH						
Logone Occidental	143	241	252	16.4	27.7	29.0
Logone Oriental	257	268	280	9.2	9.6	10.0
Mayo-Kebbi	362	533	555	12.0	17.7	18.4
Moyen Chari	285	410	427	6.3	9.1	9.4
Tandjile	259	262	272	14.4	14.5	15.1

[a]The B.E.T. prefecture was abolished in September 1972 and the three constituent sous-prefectures attached to neighboring prefectures.

Table 3. Estimated Levels of Food Consumption for Chad (10)

Commodity	Estimated Consumption, kg per Capita/Year[a]				
	1970	1975	1980	1985	1990
Millet/sorghum	157.7	158.8	157.6	154.3	148.9
Rice	7.1	7.5	8.0	8.4	8.9
Wheat	4.4	4.7	5.1	5.5	5.9
Maize	2.2	2.2	2.3	2.3	2.3
Sweet Potato	12.9	12.9	12.9	12.9	12.9
Cassava	13.7	13.9	14.1	14.4	14.6
Beans/peas	23.4	23.6	23.8	24.0	24.3
Vegetables	11.5	11.9	12.2	12.6	12.9
Peanut	19.2	19.4	19.6	19.8	20.0
Sugar	4.7	5.1	5.5	5.9	6.4
Fruit	7.1	7.3	7.5	7.7	7.9
Meat	12.0	12.5	13.2	13.6	14.3
Fish	17.3	17.8	18.4	18.9	19.5

[a]Figures for 1970 are estimated actual consumption and others are based upon an elasticity of demand.

greatest population density with 29 persons/km^2 while the average country's population density was 3 persons/km^2.

Total Food Requirements

Foods requirement projections are based on FAO data (10). Food requirements were projected through 1990 using two methods.

One projection (L) assumes that average per capita private consumption levels will remain constant and projects increases based on population changes. The other projection (H) includes elasticity of demand changes based upon a 1% annual increase in per capita food expenditures and preference changes in food purchases. Neither projection, however, differs much in magnitude from the other.

Estimated per capita food consumption in 1970 and the (H) projections for the period 1975 to 1990 are shown in table 3. Per capita consumption of millet and sorghum is projected to decrease. Per capita consumption of rice, wheat, sugar, fruit, meat, and fish is projected to increase.

Estimated (H) and (L) projections for total food requirements to 1990 are shown in table 4. Total demand for millet/sorghum is projected to increase over 1970 levels by 33% by 1980; 52% by 1985; and 71% by 1990. Increased requirements for major cereals over 1975 requirements are shown in table 5. The average increased requirement for these cereals is about 21,000 mt/year.

Urban Food Requirements

A distinction between urban and rural food demand is important in analyzing potential food demand. With large areas of potentially cultivatable land out of production, subsistence-type farming can expand to meet growing rural food demand, albeit at a subsistence food consumption level. In contrast, urban food requirements must be supplied through some form of commercial agriculture (domestic or imports). In Chad, the urban sector population is growing at three times the rate of the rural population.

Table 4. Estimated Food Requirements in Chad, 1975-1990 (10)

	Estimated Food Requirements, 1,000 mt[a]								
	1970	1975		1980		1985		1990	
Commodity	L	L	H	L	H	L	H	L	H
Millet/sorghum	574.0	662.1	667.0	763.7	763.4	879.4	860.3	1,011.9	955.8
Rice	26.0	30.0	31.7	34.6	38.6	39.8	46.9	45.8	57.0
Wheat	16.0	18.5	19.9	21.3	24.7	24.5	30.7	28.2	38.0
Maize	8.0	9.2	9.4	10.6	11.0	12.3	12.8	14.1	14.9
Sweet Potato	47.0	54.2	54.2	62.5	62.5	72.0	72.0	82.9	82.9
Cassava	50.0	57.7	58.5	66.5	68.5	76.6	80.0	88.1	93.4
Beans/peas	85.0	98.1	99.0	113.1	115.3	130.2	134.1	149.8	155.8
Vegetables	42.0	48.4	49.9	55.9	59.2	64.8	70.1	74.0	82.9
Peanut	70.0	80.7	81.6	93.1	95.0	107.2	110.5	123.4	128.3
Sugar	17.0	19.6	21.2	22.6	26.5	26.0	33.1	30.0	41.2
Fruit	26.0	30.0	30.7	34.6	36.3	39.8	42.8	45.8	50.4
Meat	44.0	50.7	52.9	58.5	63.7	67.5	76.5	77.5	91.7
Fish	63.0	72.7	74.9	83.8	89.0	96.5	105.6	111.1	125.1

[a]L is based upon per capita consumption at estimated level of 1970 and population changes and H includes elasticity of demand income effects as well as per capita consumption estimates.

Table 5. Estimated Increased Requirements for Major Cereals over 1975, Chad[a]

Food	1980	1985	1990
	- - - 1,000 mt	- - -	
Millet/sorghum	96	193	289
Maize	2	3	6
Rice	7	15	25
Total	105	211	320

[a]Based upon FAO projections considering elasticity of demand.

Table 6. Estimated Urban Requirements for Major Cereals in Chad, 1975 to 1990[a]

Food	1975	1980	1985	1990
	- - - -1,000 mt-	- - -		
Millet/sorghum	92.6	127.3	169.1	216.8
Maize	1.3	1.9	2.5	3.3
Rice	4.4	6.5	9.2	13.0
Total	98.3	135.7	180.8	233.1

[a]Based upon FAO projections considering elasticity of demand and assuming urban consumption pattern similar to national pattern.

Urban food requirements were derived for major cereals using FAO (H) per capita consumption projections and current urban population growth rates (table 6). Urban food demand for millet, sorghum, maize, and rice is expected to increase at a rate of 7,000 mt/year between 1975 and 1980 and at a rate of 9,000 mt/year between 1980 and 1985.

Cereal Supply Situation

Chad has the potential to be self-sufficient in the production of millet, sorghum, maize, and rice. In 1973 and 1974, increased cereal imports were needed to supply domestic food demand. This changing cereal supply situation for selected years between 1961 and 1974 is portrayed in table 7.

Table 7. Cereal Supply Situation in Chad (15, 16)

Crop	1961-65[a]	1970	1971	1972	1973	1974
	-Cereal Production, 1,000 mt-					
Total	937	668	693	407	389	578
Wheat	2	7	7	7	5	6
Rice paddy	29	39	51	28	28	37
Maize	11	12	4	6	6	7
Millet	895	610	631	366	350	528
	-Cereal Import, 1,000 mt-					
Total	4	10	9	10	37	81
Wheat	4	10	9	10	15	9
Other	-	-	-	-	3	37
Grain Relief Aid	-	-	-	-	19	35
	-Cereal Export, 1,000 mt-					
Total	-	<1	<1	-	-	-
	Total Supply, 1,000 mt-					
Total	941	678	702	417	426	659
Wheat	6	17	16	17	20	15
Rice paddy	29	39	51	28	28	37
Maize	11	12	4	6	6	7
Millet	895	610	631	366	350	528
Other	-	-	-	-	3	37
Grain Relief Aid	-	-	-	-	19	35
	-Per Capita Supply, kg/person-					
Total	297	183	185	107	107	161

[a]Average annual rate.

The per capita supply of cereals has varied from 107 to 185 kg/person since 1970 averaging 150 kg/person for the period. Adjustment for milling of rice and typical losses gives an average annual supply of cereals of 135 kg/person which is considerably lower than the FAO estimated consumption. Statistics for individual years are erratic, however, the trend since 1970 is toward increasing imports. Cereal imports, including grain relief aid, increased to 81,000 mt in 1974.

Reports from Chad indicate that production in 1975 has again reached 1970/71 levels. Total population, however, has increased 15% over the period 1970-1975. Thus, to achieve self-sufficiency at per capita consumption levels attained in 1970 and 1971, about 250,000 mt of additional grain was needed in 1975.

If cereal yields average 550 kg/ha, an additional 455,000 ha (using present technology) would need to be brought into cereal production. As an alternative, 25,000 mt of fertilizer nutrients, assuming a response of 10 mt of grain/mt of nutrient, could also produce the needed 250,000 mt of additional grain.

The estimated c.i.f. cost of imported sorghum at N'Djamena was 55,000 F CFA/mt or 13.7 billion F CFA for 250,000 mt. The imported cost of

nutrients at world prices plus freight is considered to be 125,000 F CFA/mt or 3.1 billion F CFA for 25,000 mt. While fertilizer use, without the appropriate cultural practices, would not produce a 10 to 1 yield response, the difference in foreign exchange requirements between imported food and imported nutrients (13.7 billion F CFA versus 3.1 billion F CFA) makes increased fertilizer use an attractive alternative in augmenting cereal supply.

It appears that Chad can benefit most by increasing crop production through both expanding cropland area and increasing productivity per unit of land. An in-depth analysis of these alternatives would be a useful guide to the government. The study would analyze the social costs and benefits from facilitating a more rapid expansion of area used for agricultural production as compared to increasing productivity by expanded use of improved technology including use of fertilizer.

It is anticipated that the cultivated area will be expanded as a result of increased rural population. In order to increase agricultural production per worker, greater use of animal traction, fertilizer, and improved cultural practices will be required.

FOOD PRODUCTION

The most important commercial agricultural products are cotton and livestock. Cotton contributes 15% to the Chadian GDP and about 70% to total exports. Livestock production, which suffered a great setback during the Sahelian drought, is now rebounding and has good export trade prospects with neighboring Nigeria. Total food production and agricultural production remained about constant from 1961 to 1971 resulting in a decreased per capita production with rising population (table 8). Between 1971 and 1974, all production indicators fell.

Two elements represent major constraints to a more rapid economic and agricultural development of the country. One is the unrest in part of the country, a situation which obliges the government to reserve the majority of its already limited budget for security spending. The other element is the landlocked position combined with an insufficient road infrastructure inside the country.

Also, as a consequence of the drought period, insects, rats, and birds are now creating considerable damage to the crops. Their control will be a necessity in the coming cropping seasons. A symbiotic weed, Striga lutea, is also becoming a major limiting factor for sorghum and millet. Its control is of high importance even for the maintenance of the present production.

Agricultural Policy Institutions

Three ministries are concerned with agro-technical development. The State Ministry in Charge of Agriculture and Livestock Production (MEAE) has the primary role in planning technical advisory service, coordination of research, and training, and the development in the agricultural sector. The principal execution agency of MEAE is the National Bureau for Rural Development (ONDR). The tasks of ONDR are: execution of

Table 8. Indices of Population and Agricultural and Food Production, Chad (15)

Year	Indices[a]				
	Population	Food Production	Agricultural Production	Per Capita Food Production	Per Capita Agricultural Production
1961	96	100	96	104	101
1962	98	102	102	104	104
1963	100	101	102	101	102
1964	102	99	100	97	98
1965	104	99	99	95	95
1966	107	100	103	94	97
1967	109	94	96	86	88
1968	112	100	106	90	95
1969	114	102	104	89	91
1970	117	101	102	87	87
1971	120	100	103	84	86
1972	123	78	82	64	66
1973	126	74	75	56	60
1974	129	74	79	58	61

[a]World--1963 = 100.

development programs through extension services elaborated by the Directorate of Agriculture on a countrywide basis with the exception of certain areas covered by specific entities; supply and marketing of agricultural inputs; extension of agricultural credit originating from the Chad Development Bank (BDT); and promotion of agricultural cooperatives and rural credit groups.

The Ministry of Public Works and Land Improvement (MTPAT) is in charge of the Rural Engineering Service and of the Rural Development and Activities Fund (FDAR). Irrigation and rural development projects are also under the MTPAT (16).

The State Ministry in Charge of Economy, Planning, Trade, and International Cocperation (MEPCCI) is in charge of national planning, commerce, and coordinating international projects. National development plans are the responsibility of the Directorate of Planning and Development within MEPCCI.

In addition, there are several organizations for rural development with specific area responsibilities. For example, entities called Experimental Sectors for Agricultural Modernization (SEMA) operate in the rice-producing areas of Bongor (SEMAB); in the Mayo-Kebbi (SEMAMK) district; and Lai-Kelo (SEMALK) in the Tandjile district.

The Lake Chad Development Corporation (SODELAC) is in charge of the development of the Chadian part of the lake region, including the provision to farmers of extension, credit, and marketing services. The importance of SODELAC will increase when polder development projects materialize.

The Bureau for the Development of the Sategui-Deressia Area (OMVSD) has recently been created to promote rice development in the Sategui-Deressia area (situated in the Tandjile district). This project is under the direction of the MTPAT.

Agricultural Credit

Several finance, credit, and marketing organizations exist in Chad. FDAR has financed a number of development activities, such as rice and wheat production programs, date palm nurseries, and fertilizer and pesticide supplies for peanut and horticultural production.

The BDT has been in charge of agricultural credit since 1963. The majority of credit operations includes the seasonal credit to cotton farmers with ONDR as intermediate agency.

Credit for fertilizer is given only to participants in the Cotton Productivity Program. Credit is extended in kind and is of the seasonal type. The farmer receives prescribed inputs on the basis of area of cotton cultivated. This in-kind credit is repaid in the form of a lump sum fixed annually by ONDR. The amount was 5,500 F CFA/ha in 1974/75 and 6,500 F CFA/ha in 1975/76. For the 1976/77 season, the sum of 7,500 F CFA/ha is planned. It is anticipated that, together with an expected decrease of costs of imported fertilizers, this amount will cover about 50% of the actual costs of the inputs supplied.

Repayment is effectuated when the farmer sells his cotton to the Chad Cotton Company (COTONTCHAD) at their purchasing centers, where he receives the full amount due to him and repays his credit to the ONDR agent present.

Repayment rate is said to average at about 95%, with regional variations. In case of bad debts, the entire village is excluded from credit in the following year.

To obtain inputs on credit, farmers have to apply to the ONDR extension officer in charge of their block. To be considered for credit they have to be known in their village as good farmers and must be willing to accept the obligations connected with the credit, i.e., the application of the cultural practices recommended. It is planned to extend these credit facilities to those development projects which will market farmers' production.

Agricultural Marketing

A Cotton Price Stabilization Fund (CSPC) was established to stabilize the price of cotton in order to balance short-term and extreme price fluctuations of the commodity on the world market.

COTONTCHAD is in charge of the buying, ginning, processing, and marketing of cotton, including exports of the lint cotton and byproducts. The period for the marketing of cotton is from October to about March or April. Trucks of the company also transport agricultural inputs as return freight for cotton from railheads and riverports to the distribution points.

Marketing activities are also carried out by SODELAC for the wheat produced in its area; by FDAR for the marketing of millet designated for storage and price stabilization; and by SONACOT for the marketing of various other products.

A Cereals Office is to be established in Chad whose main tasks are to set up emergency buffer stocks, stabilize grain prices, market cereal production, and arrive at a floor price for producers so that cereals enter increasingly into the cash economy.

Agricultural Prices

Cotton is the only crop with a fixed producer price. For many years before 1974, farmers received 26 F CFA/kg of seed cotton. In 1974, the price was raised to 33 F CFA/kg. Since 1975, 43 F CFA/kg has been paid for first quality and 25 F CFA/kg for second quality.

Table 9. Examples of Some Consumer Prices for Food Crops in 1974 and 1975, Chad[a]

Crop	1974 Annual Average Price	1974 Minimum/ Maximum Price	1974 Correspond. Months (1-12)	1975 Annual Average Price	1975 Minimum/ Maximum Price	1975 Correspond. Months (1-12)
	- - -F CFA/kg - -			- - -F CFA/kg - -		
Northern Zone						
Sorghum	38	23/57	12/5	28	23/36	3-9/1-2
Millet	44	18/66	12/5-6	24	18/28	11-12/5-6
Peanuts (unshelled)	33	20/58	12/8	19	10/29	11-12/3-4
Rice (processed)	148	129/163	8/6	163	131/185	9-10/
Southern Zone[a]						
Sorghum	31	22/41	11-12/6	32	23/37	
Millet	39	27/51	12/6	39	29/44	
Peanuts (unshelled)	18	13/22	11/7	21	16/49	
Rice (processed)	95	69/115	7/11	97	83/108	

[a]Personal communication ONDR, 1976, 1975 data available until June only.

Most domestic food crop production remains within the subsistence economy. Relatively small quantities enter the market system. Table 9 gives some indication on consumer prices for food crops in 1974 and 1975.

Fertilizer Costs and Prices

The calculation of the costs of fertilizers used in the country is complicated by the variation of quantities transported on the available transit routes. Table 10 shows average costs per unit of fertilizer material delivered to retail storage points.

Farmers covered by the Cotton Productivity Program receive a number of inputs in the form of an in-kind seasonal credit. The composition of the package and the respective actual costs/ha in 1976 follow.

Inputs	Actual Costs, F CFA/ha
100 kg NPKSB fertilizer	9,822
12 liters insecticide	8,488
Sprayers, etc.	118
Seed treatment	288
Seed bags	124
Total	18,840

Table 10. Average Costs of Fertilizers Delivered to Retail Stores, Chad (21)

Year	Cotton Mixture, F CFA/mt	Urea, F CFA/mt
1972/73	50,975	50,891
1973/74	51,691	46,054
1974/75	79,000	74,227
1975/76	101,235	128,980
1976/77	98,220	n.a.

About one-third of these input costs used to be covered by the farmers, one-third by the Cotton Price Stabilization Fund, and one-third by subsidies from external sources. Subsidies furnished by the European Development Fund (FED) are declining. They will be in the order of 20% for the 1977/78 season, and 10% for the 1978/79 season.

Cotton farmers reimburse their seasonal credit in a lump sum when they sell their product to COTONTCHAD. Amounts paid per hectare of cotton were 5,500 F CFA in 1974/75, 6,500 F CFA in 1975/76. For 1977/78, an increase to 7,500 F CFA is planned.

The official subsidized prices are 55 F CFA/kg for NPKSB compound of current compositions and 50 F CFA/kg for urea.

Crop Production

Except for the crops grown in the main cotton producing area and for rice production areas, statistical information on crops and production levels is very rough and spotty. Social unrest in parts of the country make data collection on a routine basis very difficult. Also, variation in annual rainfall affects the amount of land under cultivation in any season.

Table 11 shows the area, yields, and total production for the various crops in 1969, a year when estimated rainfall conditions were not optimal because of the upcoming drought period. The development of the cotton area from 1965/66 to 1974/75 is depicted in table 12. Various estimates of the total areas under cereal crops for the years 1973 to 1975 are given in table 13. Tables 14 and 15 provide information on the importance of food crop production in the northern and southern zones respectively. Table 16 indicates trends of crop production.

FAO estimates potential cropland area in Chad at 19.8 million ha, with about 67% of this area receiving more

Table 11. Crop Area, Yields, and Production in Chad, 1969/70 (15)

Crop	Area Harvested	Yield	Production
	1,000 ha	kg/ha	1,000 mt
Wheat	4	1,512	7
Rice Paddy	55	455	25
Maize	7	1,714	12
Millet	800	540	4,321
Sweet potatoes	14	3,786	53
Cassava	18	3,167	57
Pulses NES	185	514	95
Peanuts in shell	160	719	115
Sesame seed	40	300	12
Seed cotton	290	414	120
Cotton seed	-	-	77
Onion, dry	1	20,000	10
Dates	-	-	22
Mango	-	-	8
Cotton lint	-	-	43

Table 12. Development of Cotton Area and Yields, Chad, 1965/66 to 1974/75 (22)

Year	Area under traditional cropping, ha	Area under productivity program, ha	Total area, ha	Percentage of area under prod. program	Total production of seed cotton, mt	Mean yield of seed cotton, kg/ha
1965/66	262,762	13,216	275,978	4.8	83,097	301
1966/67	279,821	19,660	299,481	6.6	122,699	410
1967/68	273,272	25,116	298,388	8.4	101,623	340
1968/69	260,689	39,449	300,138	13.1	148,496	495
1969/70	247,047	44,115	291,162	15.2	116,748	400
1970/71	260,973	40,602	301,575	13.5	94,684	314
1971/72	259,949	41,957	301,906	13.9	108,482	360
1972/73	230,873	44,723	275,596	16.2	104,037	377
1973/74	214,174	54,852	269,026	20.4	114,394	425
1974/75	197,179	74,976	272,155	27.5	135,000	496
1975/76	209,050	127,450	336,500	37.9	n.a.	n.a.

Table 13. Estimate of Total Areas Under Cereals and Peanuts, Chad (23, 17)

Crop	Land Area, 1,000 ha		
	1973	1974	1975
Sorghum/millet	860	825/600	490
Peanuts	132	158	97
Rice paddy	n.a.	20	12

Table 14. Estimated Crop Areas and Production Levels in Southern Zones, Chad, 1974/75 (24)

Crop	Area, 1,000 ha	Average Yields, kg/ha[a]	Production, mt[a]
Millet (sole cropping)	107	600	64,200
Sorghum (sole cropping)	172	700	120,400
Peanuts (unshelled)	45.5	700	31,850
Rice (paddy)	20.2	670	13,500
Maize	5.6	n.a.	n.a.
Millet + Peanuts	16.3	290(M) 400(P)	4,700(M) 6,500(P)
Sorghum + Peanuts	96	330(S) 400(P)	31,700(S) 38,400(P)
Millet + Sorghum	11	390(M) 330(S)	3,200(M) 3,500(S)

[a]Millet = M; peanuts = P; sorghum = S.

Table 15. Estimated Millet/Sorghum Area, Production and Yields in Northern Zone of Chad, 1970-76 (24)

District/Zone	Year					
	1970	1971	1972	1973	1974	1975
	Area, 1,000 ha					
Kanem	48	46	20	40	40	40
Chari-Baguirmi	95	108	100	100	125	133
Batha	105	130	80	100	100	116
Guera	41	53	50	50	60	61
Ouaddai-Biltine	180	180	140	140	155	165
Zone	469	517	390	430	480	515
	Production, 1,000 mt					
Kanem	25	20	4	16	14	15
Chari-Baguirmi	65	66	51	34	56	80
Batha	50	80	24	18	35	58
Guera	32	32	22	16	21	33
Ouaddai-Biltine	90	110	42	25	58	91
Zone	262	308	143	109	184	277
	Yield, kg/ha					
Zone	558	595	368	253	384	538

[a]Figure overestimated; heavy losses caused by pests, rats, and birds.

than 600 mm of rainfall/year (10). About 1,125,000 ha (6% of the potential) is in cultivation (17). About 270,000 ha is in cotton production. The remaining cultivated area (855,000 ha) is predominantly in millet and sorghum production.

Patterns of Land Use

In 1974, the population density was estimated at 3.6 persons/ha of cultivated land. The average size of farm holdings was about 2.7 ha, with an average of 8.7 persons per holding.

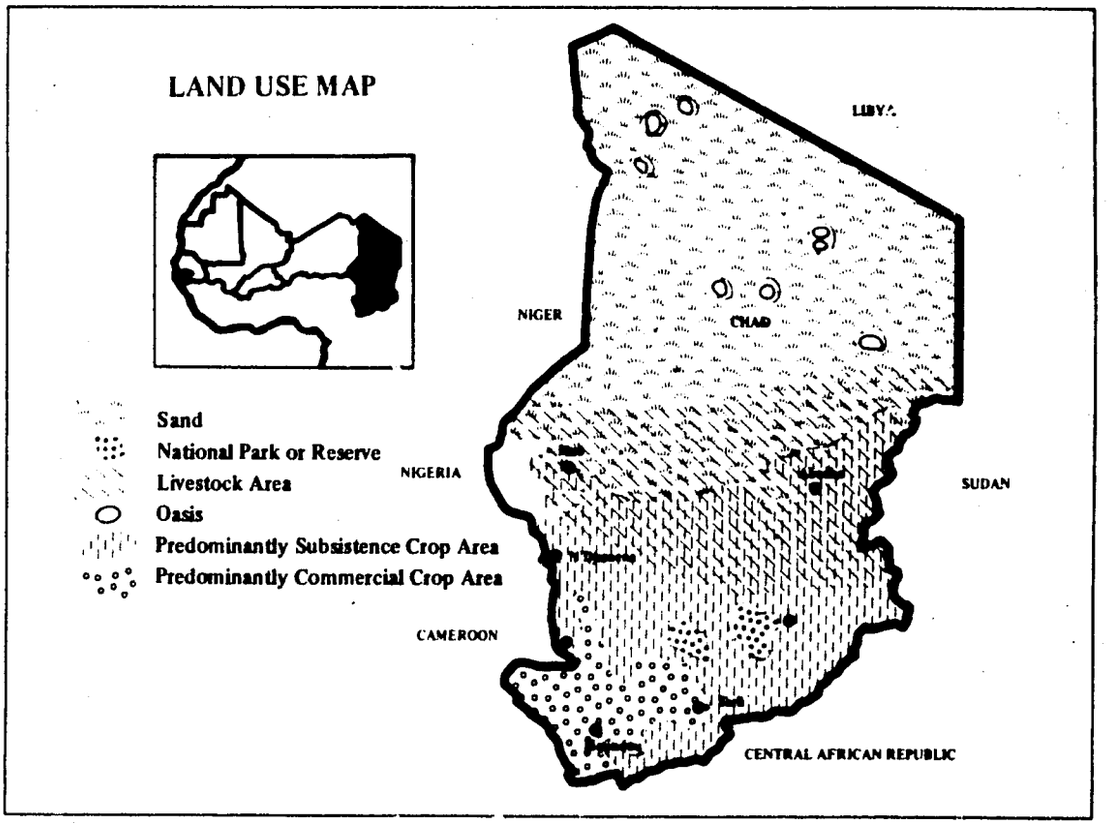


Table 16. Trends of Crop Production, Chad (15)

Crop	Production, 1,000 mt					
	1961-65	1970	1971	1972	1973	1974
Cereals, total	937	668	693	407	389	577
Wheat	2	7	7	7	5	6
Rice paddy	29	39	51	28	28	37
Maize	11	12	4	6	6	7
Millet	895	610	631	366	350	528
Roots and tubers	92	107	110	93	95	98
Sweet potatoes	50	52	53	45	45	46
Cassava	42	55	57	48	50	52
Pulses	65	95	95	65	70	70
Peanut in shell	140	115	75	45	50	50
Sesame seed	5	9	6	6	5	6
Seed cotton	86	95	109	104	108	115
Cottonseed	56	58	65	62	65	70
Onion dry	10	10	10	5	6	6
Dates	21	22	22	15	15	15
Mangoes	5	8	8	5	6	6
Cotton lint	31	37	41	38	41	43

Table 17. Projected Development of Cotton Area, Chad, 1977/78 to 1981/82 (24)

Cultural Practice[a]	Land Area, 1,000 ha				
	1977/78	1978/79	1979/80	1980/81	1981/82
Traditional cropping	145	135	125	115	105
Single fertilizer dose	155	168	180	193	205
Double fertilizer dose	5	7	10	12	15
Total area planned	305	310	315	320	325

[a]Single fertilizer dose is 100 kg/ha of NPKSB mixture and double dose receives an additional 50 kg/ha of urea or 100 kg/ha of NPKSB as topdressing.

No land titles exist in Chad. The land belongs to the state and is placed at the disposal of the farmers. Local chiefs play an intermediate role in the distribution. The general farming system follows the practice of recurrent bush fallow cultivation as a means to maintain or restore natural soil fertility.

Intercropping of several species within a field is widely practiced in the south (except in the cotton producing areas). It is less frequent in the northern zone. Cotton-sorghum-fallow is the typical crop rotation in the southern zone. Intercropping helps conserve soil moisture during dry spells and during heavy rains; provides for part of the nitrogen supply when legumes are in the mixture; and provides some security against total crop failure.

Crop Production Projects

A variety of government development plans have been designed to increase production of seed cotton, rice, wheat, vegetables, tobacco, millet, and sorghum (18).

Cotton Development Projects--The current 10-year development plan (1971-1980) calls for production of 250,000 mt of seed cotton by 1980 through a program to increase farmer productivity. Extension educational activities focus on improved general cultural practices, the use of fertilizers, and the application of sufficient insecticide treatments. Table 17 indicates the planned extension of the cotton area under intensified cropping until 1981/82.

Rice Development Projects--Rice production projects covering an area of about 55,000 ha had a total production of about 51,000 tons of paddy in 1971. This level of production has since declined due to unfavorable climatic conditions. The main production areas are in the Tandjile and Mayo-Kebbi districts, using the high water levels of the Logone and Chari Rivers (19).

The 5-year plan for the integrated development of southern Chad, 1972/73-1976/77, calls for increased rice production. A target of 50,000 mt of paddy was set for 1976/77. Actual production reached about 14,000 mt in 1974/75. Of this quantity, it was estimated that 50% will remain in the subsistence economy; 10% will be used for seeds; and 40%, or about 20,000 mt, will be marketed. Table 18 shows the original planning projections.

The integrated development project covers four areas: Production Unit A, north of Bongor, with a total area of 57,000 ha of which 12,000 ha

Table 18. Development Plan for Rice Production in Southern Chad, 1970/71-1976/77 (20)

Year	Fertilized	Non-fertilized	Total
	- - - - - -Area, ha - - - - -		
1970/71	907	38,380	39,287
1974/75	4,750	35,400	40,150
1975/76	6,200	33,950	40,150
1976/77	7,850[a]	32,300	40,150
	- - -Paddy Production, mt - -		
1970/71	2,594	36,561	39,155
1974/75	10,395	38,077	48,472
1975/76	13,030	38,317	51,347
1976/77	15,995	37,128	53,123

[a]Of which 1,000 hectares were foreseen with two crops per year in the Production Unit B ("Casier B") of Bongor.

are flooded annually without water control; Production Unit B, with 500 ha producing about 8 mt of paddy/ha in two crops/year; production units at Doba; and farming areas in various small valleys with seasonal streams. (Production Units B and Doba receive technical assistance from the People's Republic of China.)

Small programs also exist to increase irrigation use among small farmers along the Chari River; wheat production in various oases; vegetable production around N'Djamena; and tobacco production for possible future export.

In Production Unit A, 100 kg/ha of urea is the recommended fertilizer use. In Production Units B and Doba, 100 kg/ha of the cotton fertilizer and 200 kg/ha of urea as topdressing are recommended.

A rice growing area in the Logone valley has 55,000 ha that can potentially be put into production. At present, upland and flooded rice is grown in the area, the latter without water control. A project proposal foresees the development of 4,000 ha in polders, together with the respective infrastructure and services. Another 7,000 ha would benefit from improved water control. The proposal includes a feasibility study for the development of an additional 5,000 ha. OMVSD would be the government agency in charge of the project. Planned duration is 5 years (1977-1981).

An additional project is to develop about 2,000 ha for rice cultivation on flood plains. Plans include using urea on about 50% of the area by 1980. Projected duration of the project is 5 years (1977-1981).

Lake Chad Polders Project--The Lake Chad Polders area, situated in the northeastern part of Lake Chad, has about 60,000 ha of land with a high potential for crop production. Soils are fertile and water supply often permits up to three crops/year. Since 1951, the area has gone through periods of development and setbacks, the latter due to heavy flooding of the lake and drought.

Under controlled water conditions, yields of 2.5 mt/ha of seed cotton and 2.5 mt/ha of wheat are easily obtained (7). One crop of cotton and wheat is foreseen to be produced each year. SODELAC would be the government agency in charge of the project. No decision concerning financing has been taken as yet. Planned duration of the project is 4 years. In view of the high soil fertility level, no fertilizer use is envisaged for cotton in the early years of the project. On wheat, an annual application of 45 kg N and 45 kg P_2O_5/ha is foreseen, based on available research findings (7).

Peanut Project--Peanut production in southern Chad has continuously decreased in recent years. Production in 1969 was 115,000 tons of unshelled peanuts from an area of about 160,000 ha. Production is now at a subsistence level. The three oil mills with a total production capacity of 4,000

mt/year of peanut oil have closed down since 1972/73 for lack of supplies (20). The corresponding annual requirements of these mills would be in the order of about 7,000 mt of shelled or about 10,000 mt of unshelled peanuts.

A project proposal calls for the development of about 5,000 ha in southern Chad, centered around Koumra. Planned duration of the project is about 5 years (1977-1981). It is assumed that by the end of the project's operation, about one-half of the project area will receive fertilizers. Specific fertilizer recommendations are not available. Probable nutrient requirements in the order of importance are phosphorus, sulfur, nitrogen, and possibly potash.

Sugar Project--The existing sugar refinery imports raw sugar from the Republic of the Congo and from Europe when supplies from the Congo are short. Experimental agricultural research work, terminated in 1973, has shown that sugarcane can be produced locally at satisfactory levels.

A project is being developed for the installation of a commercial sugarcane plantation in connection with a mill for the production of raw sugar. Near Banda, about 20 km southeast of Sarh on the Chari River (20), the initial area under cane will be in the order of about 3,400 ha (to be in production about 5 years after initiation of the project). It can be assumed that the plantation will have a relatively high consumption of fertilizers. Detailed fertilizer recommendations are not yet available.

Development of the Sahelian Zone--A rural development program to improve the economic situation for the Sahelian zone has been proposed by MEAE (18). The main tasks will be: (a) to increase millet and sorghum production so that the calorie intake of the population can be improved and to allow for the creation of reserves; (b) to increase peanut, sesame, and karkade (Ibiscus sabdariffa) production to levels corresponding to market potentials. Planned duration of the project is 5 years (1977-1981). ONDR would be in charge. Longer-term projections include also the development of citrus, banana, and vegetable production. Fertilizers might increasingly be used on these crops from 1980 onwards.

Because of economic constraints, general use of fertilizer will not be feasible, at least in the near future. The effect of these constraints on agricultural development should, however, be assessed.

AGRICULTURAL RESEARCH

Agricultural research on cotton production is carried out by the French Research Institute for Cotton and Textiles (IRCT). Its central office is at N'Djamena, with stations in the cotton zone at Bebedjia and Tikem.

Research on other crops, especially food crops, comes under the MEAE, where research activities are underfinanced and understaffed. The main station is located at Deli, with a number of partially equipped substations functioning.

Table 19. Mean Yield Response of Cotton to Fertilizer in 54 Confirmation Trials on Farmers' Fields in Chad, 1971-73 (26

Treatment, kg/ha			Seed Cotton Yield, kg/ha	Yield Increase		
N	P_2O_5	K_2O		kg/ha	kg/kg of Nutrient	kg/kg of Supplemental N
-	-	-	800	-	-	-
22	18	14	1,063	263	4.87	-
45	18	14	1,250	445	5.93	7.91

There are other stations in the Guini polder, SODELAC area, and at Boumo, OMVSD area. These stations will eventually be rehabilitated when the development projects materialize.

For farmers adopting all recommended practices, the suggested fertilizer application rates for cotton are: 100 kg/ha of 21-18-14-5S-1.8B and an additional 50 kg/ha of urea 50 days after planting. For farmers adopting only part of the recommended practices, the suggested fertilizer application rate is 100 kg/ha of 21-18-14-5S-1.8B (25). IRCT is evaluating the possibility of changing the recommendation for urea to an additional 100 kg/ha of the cotton mix.

In the Doba Production Unit, 100 kg/ha of cotton mix is recommended for rice. In other areas, the general recommendations are for 75 kg/ha of urea for rice and 50 kg/ha of urea for sorghum. In the Lake Chad polders area, 45 kg/ha each of N and P_2O_5 is recommended for wheat.

Crop Response to Fertilizer

It is generally admitted that for small farmers to use fertilizers, the value of the last increment of yield increase must be twice the cost of fertilizer needed to produce the increased yield. This calculation is called the marginal "value:cost ratio."

In this report, average value:cost ratios are used to indicate the profitability of fertilizer use. When using average value:cost analysis, ratios somewhat greater than 2 would be necessary to indicate an economic incentive to the farmer to adopt or increase the use of fertilizer.

In the absence of crop response data to individual nutrient rates, yield response and economic returns from 54 confirmation trials for cotton are presented (26). As a surrogate to crop response data, sorghum and rice calculations are shown to illustrate the crop responses needed, using 1976 farmer price of urea and a range of producer prices for the grains.

Average seed cotton yield response to fertilizer is shown in table 19. The response to the second increment of added nitrogen is 7.9 kg of cotton/kg of N while the response is only 4.9 kg/kg of N + P_2O_5 + K_2O for the first increment of fertilizer. This indicates that the greatest response is to N. Although this type of data does not establish with certainty the relative response to N, P_2O_5, or K_2O, it is very doubtful that there was any significant response to the P_2O_5, K_2O, or S.

Table 20. Economic Returns for Seed Cotton to Fertilizers at Various Prices, Chad[a]

Package Cost, kg/ha	Fertilizer Cost, F CFA/kg of Material[b]		Value:Cost Ratio[c]		
	Cotton Mix	Urea	Light Dose	Heavy Dose	Supplemental N
-	98.2[d]	120.0[d]	1.15	1.21	1.30
-	55.0[e]	50.0[e]	2.06	2.39	3.13
5,500	28.6	13.2	3.95	5.36	11.86
6,500	33.6	16.0	3.37	4.60	9.78
7,500	39.0	18.0	2.90	3.36	8.81

[a]Based upon yield responses in table 19.
[b]Cost of fertilizer within the production package was calculated to be proportional to actual fertilizer and actual total package cost.
[c]Seed cotton value--43 F CFA/kg, added value from light dose--11,309, heavy dose--19,135, and supplemental N--7,826 F CFA/ha.
[d]Actual delivered cost.
[e]Official farmer price.

The economics of fertilization for varying fertilizer prices based upon the above response data are shown in table 20. Value:cost ratios are less than 2 when true fertilizer costs were used. It appears that farmers can obtain a reasonable return on investment from fertilizing cotton with cotton prices at the 1976 official level. Farmers cannot afford to apply nutrients that are not needed, since the recommended rates are already at the margin in terms of return.

Calculations in table 21 show that for the official 1976 price for urea, it would be of potential economic benefit for a farmer to use N for paddy if he can sell the paddy for

able 21. Required Yield Responses of Rice and Sorghum to Obtain a Value:Cost Ratio of 2 at Various Producer Prices, Chad

Producer Price F CFA/kg[a]	Required Yield Increase for Value:Cost Ratio of 2[b]		
		kg/ha	
	kg/kg of N	25 kg of N	50 kg of N
	- - - - - - - - - - -	Paddy Rice	- - - - - - - - - -
22	10.1	252	504
26	8.5	212	424
29	7.7	192	384
	- - - - - - - - - - -	Sorghum	- - - - - - - - - -
9	24.7	618	1,236
13	17.1	428	856
15	14.8	370	740

[a]Calculated from range of retail prices in table 9 assuming 33% loss in rice processing and diminished by 60% for transport and margins.
[b]Value of N = 111 F CFA/kg (urea at 50 F CFA/kg).

at least 22-26 F CFA/kg. However, at 1976 N prices, the farmer would likely need to sell sorghum at near 300 F CFA/kg to have an economic incentive to use N for sorghum.

Better defined crop response data on the effect of fertilizers on all crops grown in Chad are needed. Further, a feasibility study on the economics of fertilizer use on these crops is needed. Crop and fertilizer prices would need to be balanced, based on the yield increasing effect obtained by fertilizer use, so as to provide an incentive for the farmer to use fertilizers and thus increase crop production.

It can be anticipated that cereal crops in rotation with cotton (which receives fertilizers) will benefit from the residual fertilizer. However, data on the response of cereals to residual fertilizers are unavailable. Further research is again needed to determine the actual benefit.

FERTILIZER USE AND POTENTIAL

Fertilizer Use

Cotton is the principal crop in Chad using fertilizers. Annual consumption is about 12,000-15,000 mt of NPKSB mixture and urea. In 1976, a relatively small percentage of the total cotton area received urea topdressing.

Annual fertilizer use on other crops, mainly rice, totals about 1,000 mt of urea. Further expansion in fertilizer use on rice and peanuts may require subsidies.

Millet and sorghum production remain substantially in the subsistence economy system. At present, only relatively small quantities can be marketed for cash, as Chad has a small wage earning population. Excess production in millet and sorghum is usually bartered for other produce. This situation acts as a serious constraint to increased fertilizer use. Under barter economy conditions, yields of millet and sorghum can only be expected to increase through the application of labor intensive methods rather than capital intensive investments. Such yield increases could be achieved by the use of improved varieties adapted to the ecological conditions and by the application of improved cultural practices not requiring costly inputs.

Total fertilizer use for the period 1961 to 1966 was about 670 mt of an NPK mixture. During the five years 1966-1970, total consumption rose to some 3,300 mt of the same mixture or 1,640 mt of nutrients (table 22). In 1975/76 about 6,000 mt of fertilizer nutrients was used. Fertilizer imports for the 1975/76 and 1976/77 seasons and projections for the 1977/78 seasons are given in table 23.

Potential Fertilizer Use

Two hypotheses have been used in making fertilizer projections through 1985. Projections of nutrient use are similar for the two methods of calculation. One series is linear projections based on past trends in

fertilizer nutrient and materials consumption (tables 24 and 25). This predicts about 11,000 and 15,000 mt of nutrients to be used in 1980 and 1985, respectively. The other series, also linear projections, is based on the hypothesis that by 1985 fertilizer will be used on about 50% of the development project areas which foresee the use of fertilizer. A summary of projected nutrient consumption by crop for the second hypothesis is shown in table 26 with additional detail for individual crops shown in appendix 1.

Table 22. Estimated Fertilizer and Nutrient Consumption, Chad, 1961-1977[a]

Year (Season)	Fertilizer Material, mt			Nutrient, mt			
	Cotton Mixture		Urea	N	P_2O_5	K_2O	Total
1961/66	30-20-0-10S[b]	674		202	135		337
1966/70	30-20-0-10S	3,279		984	656		1,640
1970/71	22-18-14-5S-1.8B[c]	4,192		922	755	587	2,264
1971/72	22-18-14-5S-1.8B	4,472		984	805	626	2,415
1972/73	22-18-14-5S-1.8B	2,818	312	760	507	395	1,662
1973/74	22-18-14-5S-1.8B	4,150	487	1,266	747	581	2,594
1974/75	22-18-14-5S-1.8B	8,000	982	2,202	1,440	1,120	4,762
1975/76	22-18-14-5S-1.8B	10,000	1,415	2,837	1,800	1,400	6,037
1976/77[d]	22-18-14-5S-1.8B	11,000	1,415	3,057	1,980	1,540	6,577
1977/78[d]	22-18-14-5S-1.8B	2,000+					
	19-12-19-5S-1.8B	15,000	500	3,515	2,160	3,130	8,805

[a]1961/66-1975/76 communication ONDR giving nature of mixture (NPS and NPKSB) and tonnage material.
[b]20-30-0-10S is assumed following information given in reference (4).
[c]Based on composition used in 1975/76.
[d]Figures based on imports and assumed consumption.

Table 23. Chadian Fertilizer Imports for 1975/76-1977/78

Year	Cotton Mix		Urea, mt
	Formula	mt	
1975/76	22-18-14-5S-1.8B	10,000	1,415
1976/77	22-18-14-5S-1.8B	13,000[a]	1,915[b]
1977/78	19-12-19-5S-1.8B	15,000[c]	

[a]3,000 mt supplied through FAO International Fertilizer Supply Scheme (IFS).
[b]1,000 mt supplied through IFS. In view of the arrival of these quantities at the port of Douala by May 1975 it is assumed that the majority of this material was carried over for the 1976/77 agricultural season, which will be reflected in the consumption table.
[c]Planned import figure, final nutrient concentration might be slightly higher.

Table 24. Linear Projections of Fertilizer Nutrient Consumption, Chad, 1978-1985[a]

Year (Season)	Annual Consumption, mt of Nutrients[b]			
	N	P_2O_5	K_2O	Total
1978/79	3,880	2,400	3,400	9,680
1979/80	4,250	2,600	3,650	10,500
1980/81	4,620	2,800	3,900	11,320
1981/82	4,990	3,000	4,200	12,190
1982/83	5,360	3,200	4,400	12,960
1983/84	5,730	3,400	4,700	13,830
1984/85	6,100	3,600	4,950	14,650
1985/86	6,470	3,800	5,200	15,470

[a]For N and P_2O_5 based on period 1970/71-1977/78, for K_2O the linear annual increase 1970/71-1976/77 has been increased by 50% of linear annual projected increase for the period 1970/71-1977/78, as a continuation of the sharp increase in K_2O consumption from 1976/77 to 1977/78 is most probably not to be expected.

[b]Rounded figures for single nutrients.

Table 25. Summary, Projections of Fertilizer Materials Consumption, Chad, 1978-86

Year (Season)	Annual Consumption, mt of Materials						
	Urea	TSP	MP	DAP	19-12-19	15-15-15	Total
1978/79	137	25	17	27	18,250	220	18,676
1979/80	378	55	68	88	20,000	540	21,129
1980/81	728	90	153	193	21,750	960	23,874
1981/82	1,164	125	289	349	23,500	1,400	26,827
1982/83	1,305	140	323	391	24,600	1,572	28,331
1983/84	1,446	155	357	433	25,700	1,744	29,835
1984/85	1,586	170	391	473	26,800	1,916	31,336
1985/86	1,733	185	425	515	27,900	2,100	32,858

Table 26. Summary, Projections of Nutrient Consumption, Chad, 1978/79 to 1985/86

		Estimated Nutrient Consumption, mt						
Year	Nutrient	Cotton	Rice	Wheat	Cereals	Sugarcane	Peanuts	Total
1978/79	N	3,467	60	5	6	15		3,553
	P_2O_5	2,190	30	5	3	8	11	2,247
	K_2O	3,467	30		3	10		3,510
	Total	9,124	120	10	12	33	11	9,310
1979/80	N	3,800	150	9	12	60		4,031
	P_2O_5	2,400	75	9	6	32	25	2,547
	K_2O	3,800	75		6	40		3,921
	Total	10,000	300	18	24	132	25	10,499
1980/81	N	4,132	270	18	18	135		4,573
	P_2O_5	2,610	135	18	9	72	40	2,884
	K_2O	4,132	135		9	90		4,366
	Total	10,874	540	36	36	297	40	11,823
1981/82	N	4,465	390	27	30	255		5,167
	P_2O_5	2,820	195	27	15	136	56	3,249
	K_2O	4,465	195		15	170		4,845
	Total	11,750	780	54	60	561	56	13,261
1982/83	N	4,674	438	30	34	285		5,461
	P_2O_5	2,952	219	30	17	152	63	3,433
	K_2O	4,674	219		17	190		5,100
	Total	12,300	876	60	68	627	63	13,994
1983/84	N	4,883	486	34	37	315		5,755
	P_2O_5	3,084	243	34	19	168	70	3,618
	K_2O	4,883	243		19	210		5,355
	Total	12,850	972	68	75	693	70	14,728
1984/85	N	5,092	534	37	41	345		6,049
	P_2O_5	3,216	267	37	21	184	77	3,802
	K_2O	5,092	267		21	230		5,610
	Total	13,400	1,068	74	83	759	77	15,461
1985/86	N	5,301	585	40	45	375		6,346
	P_2O_5	3,348	292	40	23	200	83	3,986
	K_2O	5,301	292		23	250		5,866
	Total	13,950	1,169	80	91	825	83	16,198

FERTILIZER SUPPLY

The principal supplier of fertilizers in the past has been the Fertilizer and Chemical Products Company of Equatorial Africa (SEPCAE) at Douala, Cameroon. SEPCAE is a commercial firm of the Commercial Nitrogen and Alsatian Potash Company (SCPA), Paris, which also holds major shares in the fertilizer factories in Abidjan and Dakar.

Raw Materials for Fertilizers

The most promising potential raw materials for fertilizers are discussed below. More detailed information appears in appendix II.

Phosphate--So far, phosphate deposits have not been identified in Chad. However, there is a strong feeling in the Ministry of Mines that phosphates do exist. The basis for this feeling is the geological history of the Chad Basin and the known presence of other minerals, such as diatomite, which usually appear along with phosphates. The location in question is the Bahr-er-Ghazal area, a depression running northeast from the eastern end of Lake Chad.

The manager of the UNDP assisted Mining Project CHD/72/002 is of the opinion that a radiometric survey by slow flying aircraft or helicopter would be appropriate for a first reconnaissance. The recommended use of radiometrics is based on the fact that phosphates usually contain traces of uranium. Radiometric work for other minerals in Chad has been subcontracted by UNDP to Polservice, a Polish firm.

Other Minerals--Deposits of trona are currently being exploited in the depressions of the northeastern coastal area of Lake Chad. Trona is used for human consumption as an alternative to salt and as a food supplement for animals.

The deposit is situated in the province of Kanem between 13°00'-14°30'N and 13°30'-15°30'E. The mineral is exploited from about 500 shallow depressions, encompassing a total area of about 13,000 ha. Current production is about 10,000 mt/yr. Part of this is consumed in the country and part exported to Nigeria by boat across Lake Chad.

The majority of the mineral as mined is trona (chemical composition $NaHCO_3.Na_2CO_3.2H_2O$) with the next major constituent being gaylussite ($CaCO_3.Na_2CO_3.5H_2O$). Natron ($Na_2CO_3.10H_2O$) would not be expected since it is unstable at the prevailing temperatures (above 32°C) in the depressions.

The material occurs in two colors: black and white. It is present in a superficial layer of low bulk density up to 40 cm thick followed by a heavier crust about 2 m thick. Total available material is estimated at about 6.5 million mt. Although the replacement mechanism is not yet known, the material is renewable. The results of analysis of two samples each of the white and black material are shown in table 27. Current prices for the white material are 2.85 F CFA/kg at the producer and 19.00 F CFA/kg to the consumer in N'Djamena. The producer price for black material is 6.00 F CFA/kg and the price to Nigerian consumers is about 27 F CFA/kg.

Trona can be used in conjunction with phosphate rock to produce a

Table 27. Analysis of Four Samples of Trona from Chad (30)

	meq/100 g			
	White		Black	
Compound	Sample 1	Sample 2	Sample 3	Sample 4
Ca	6	6	6	6
Mg	12.5	12.5	12.5	12.5
K	7.7	1.5	1.5	1.5
Na	1,304.3	1,356.5	1,356.5	1,382.6
NO_3^-	-	-	Traces	-
SO_4^{--}	-	-	-	-
Cl^-	120	40	120	100
$CO_3^{--} + CO_3H^-$	1,252	1,300	1,300	1,325

fertilizer material known as Rhenania phosphate if phosphate rock of sufficient quantity and quality are located relatively near the trona deposits. Rhenania phosphate is produced by calcining in a kiln a mixture of soda ash (from trona in this case), silica, and phosphate rock.

Petroleum--The information available on Chadian oil reserves is somewhat sketchy. There is one refinery of 2,000 mt/year capacity now operating on imported oil. A consortium headed by CONOCO has been exploring for oil in Chad since 1970. Significant quantities of oil were found in two of nine drilled wells. One well tested about 3,000 barrels/day (27). The significance of oil as an export product will not likely be known before 1980, although these oil reserves do appear to be promising for domestic use.

Production and Plans

Chad currently does not have any facilities for producing fertilizers and has no plans for production facilities in the near future. The nearest manufacturing plant is Cameroon Fertilizer Company (SOCAME) in Douala, Cameroon. The plant is coming on stream in mid-1976 and is expected to reach full capacity in 1977. Theoretically, some excess production will be available at least through 1980 for export to Chad, Central African Republic, and eventually Zaire.

There is a superphosphate plant in Kaduna, Nigeria, which was built primarily to supply the local demand in Nigeria. However, railway transport conditions from Kaduna to Maiduguri are not favorable for export to Chad, at least in the near future.

TRANSPORTATION

Chad is the most inland landlocked country of the Sahel. The primary urban and economic centers are between 1,700 and 3,000 kilometers from the nearest ocean port. Four primary international routes are

available using road, rail, and water transportation. Ports in Cameroon, Congo, and Nigeria are used by Chad on the Atlantic Ocean for trade. The Red Sea may also be accessed via Sudan. All international routes are time consuming and very costly. In 1971/72 transportation costs accounted for 56% of the average domestic price paid for fertilizer.

International Transportation

The primary international routes (see Transportation Map in Regional Overview, Vol. 1) are the transequatorial route, the trans-Cameroon route, and the Nigerian routes via Lagos and Port Harcourt (28).

The transequatorial route employs three modes of transport--road, rail, and water. Arriving at the Republic of the Congo port, Point Noire, products move 515 km inland via the Congo-Ocean railway to Brazzaville, Congo. Following transshipment, the goods move 1,300 km on the Congo-Oubangui Rivers to Bangui, in the Central African Republic, which are generally navigable throughout the year. From Bangui to N'Djamena, the capital of Chad, two road routes are available, via Sarh, Chad (1,460 km) and via Bongor, Chad (1,135 km). Total distance from Point Noire to N'Djamena is 3,275 km via Sarh and 2,950 km via Bongor. The road linking Bangui to N'Djamena via Bongor is subject to seasonal flooding, however, via Sarh this is not a problem. Average transport time for products destined for N'Djamena using the transequatorial route is about 3 months.

The trans-Cameroon route is Chad's nearest ocean access. Entering Port Douala, Cameroon, products move by rail 930 km to N'Gaoundere, Cameroon. From N'Gaoundere to N'Djamena via Garoua, an all-weather road is available (762 km); total distance to N'Djamena is 1,692 km. Moundou, a major market center in western Chad, may also be accessed from N'Gaoundere. The distance from N'Gaoundere to Moundou is about 625 km. The Chad section of the road to Moundou is subject to seasonal flooding. The rail trip from Douala to N'Gaoundere (930 km) requires about 4 days and is not subject to seasonal delays. Transport time required for the road trip from N'Gaoundere to N'Djamena (762 km) varies from 3.5-5.0 days with a total Douala to N'Djamena transport time of 7.5-9.0 days.

The Nigerian routes available to Chad in accessing the Atlantic Ocean are predominately rail. From the Port of Lagos the railway extends 1,790 km to Maiduguri in northern Nigeria. From Port Harcourt, the railway also extends to Maiduguri (1,445 km). A road subject to seasonal flooding links the railroad with N'Djamena. Total distances via the Lagos and Port Harcourt routes are 2,039 and 1,694 km respectively. Due to the severe congestion in the two Nigerian ports and the poor condition of the rail system to Maiduguri, this route is of little current value to Chad in accessing world markets.

The Benue route, also through Nigeria, involves water transportation from Port Warri, Nigeria, to Caroua, Cameroon (1,590 km) and truck transport to Moundou or to N'Djamena. Total distance via the Benue River route is 2,170 km to N'Djamena and 1,995 km to Moundou. The use of this route is limited by the seasonally navigable Benue River and the shortage of barges.

The Sudanese route is another route which holds potential for serving eastern Chad (particularly during the rainy season). A railway extends from Port Sudan on the Red Sea to Nyala, Sudan (2,450 km). Poor roads and tracks connect Nyala with Abeche, Chad (400 km). The road from Nyala to Abeche is subject to flooding. The long rail trip from Port Sudan to Nyala may render favorable

Table 28. Composition of Cost of Fertilizer Imports, N'Djamena, Chad (29)

International Route/Date	Cost, F CFA/mt						Total Cost, % of c.i.f.
	c.i.f. Seaport[a]	Port Dues	Stevedoring and Export Handling	Transport Charges	Customs Fees	Total Cost	
Benue							
September 1973	30,425	220	2,620	14,020	625	47,910	157.5
February 1974	25,500	220	2,620	14,020	669	43,029	168.7
Trans-Cameroon							
September 1973	30,425	125	3,299	17,720	1,302	52,871	173.8
February 1974	25,500	125	5,300	16,370	1,494	48,789	191.3
Transequatorial							
September 1973	30,425	690	5,036	20,069	1,049	57,269	188.2
February 1974	25,500	690	5,301	20,180	1,097	52,768	206.9

[a]Cotton mixture 22-18-14-5S-1.8B.

shipping rates, and if large quantities of products are being channeled to eastern Chad the potential of this route should be investigated.

In 1970, the transequatorial route carried about 47% of Chad's international traffic (40% of import traffic), the Nigerian routes about 37% (50% of import traffic), and the trans-Cameroon 15% (9% of import traffic). However, this situation has changed due to the bottleneck in Nigeria. Currently three routes (trans-Cameroon, Benue, and transequatorial) are used by Chad in accessing world markets. Although these routes are currently capable of handling the volume of Chadian imports and exports, their capacities would be severely taxed if projected volumes of agricultural exports are realized. (Chadian cotton fiber exports are expected to increase to about 60,000 mt/year by 1980.) The capacities of these three route are: (a) trans-Cameroon--50,000 mt/year; (b) Benue--10,000 mt/year; and (c) transequatorial--20,000 mt/year.

For fertilizer imported through N'Djamena in 1973 and 1974, the Benue route was the cheapest followed by trans-Cameroon. Actual costs of the cotton grade delivered to N'Djamena by the three major routes are given in table 28. The effect of transportation on the delivered cost is reflected as total cost as a percentage of the c.i.f. value at the receiving port. In 1974 the delivered cost through Benue was approximately 169% of the c.i.f. value at Port Warri as compared with 191% for the trans-Cameroon and 207% for transequatorial routes. Transportation costs to access N'Djamena from international ports are shown in table 29. In 1974, the trans-Cameroon and transequatorial routes cost 33-56% more than the Benue route.

Domestic Transportation

The primary mode of transportation within Chad is truck. The road infrastructure is approximately 32,000 km in length, of which 25,000 km (78% of all roads) is track and unmarked roads (28). There are no railroads in Chad and water transportation is concentrated on Lake Chad and the Chari River between Lake Chad and Sarh.

Most of the roads and tracks are south of a line extending from Lake Chad to Abeche. Further, the heaviest

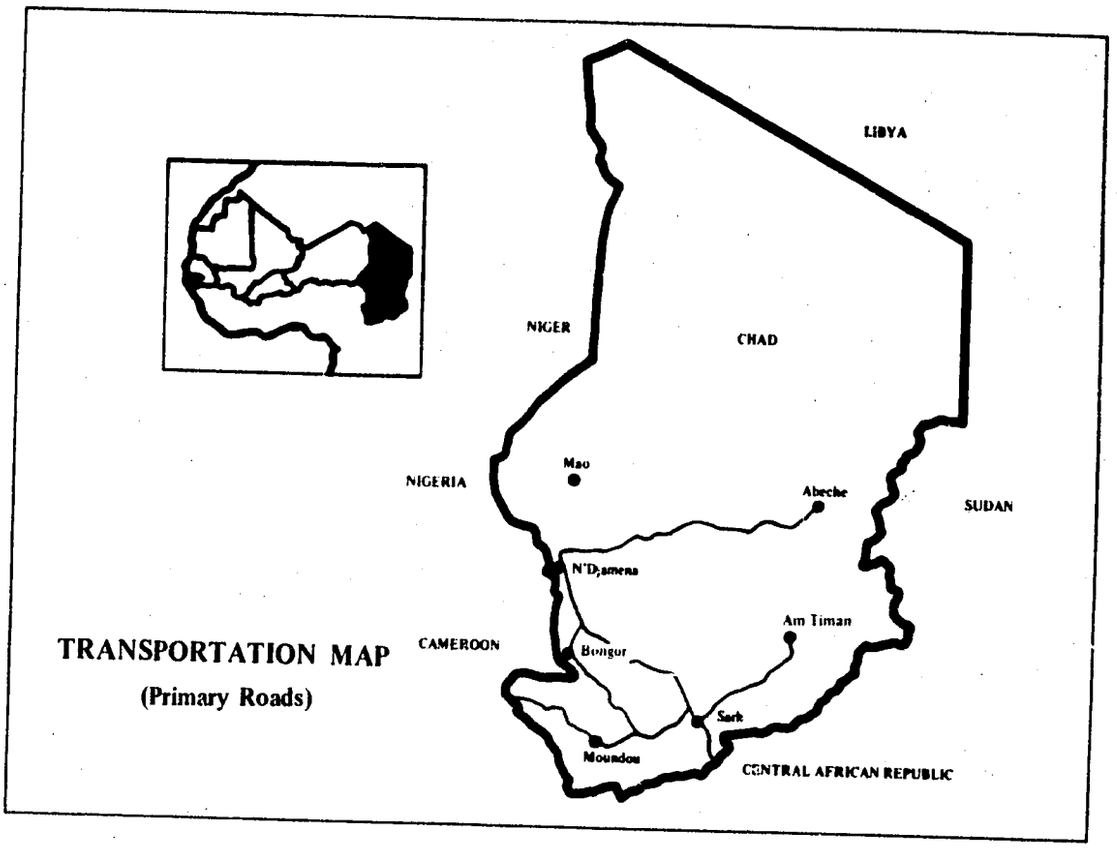


Table 29. Comparative Study of Transportation Costs of the International Routes Used to Access N'Djamena, Chad (29)

International Route/Date	Transportation Costs F CFA/mt	Transportation Costs % of Cheapest Route
Benue		
September 1973	17,485	100
February 1974	17,529	100
Estimated 1976	22,700	100
Trans-Cameroon		
September 1973	22,446	128
February 1974	23,289	133
Estimated 1976	35,500	156
Transequatorial		
September 1973	26,839	154
February 1974	27,268	156
Estimated 1976	29,000	128

concentration of road and track network exists in the more populous southwest. The roads from N'Djamena to Sarh (609 km) and from N'Djamena to Bongor (240 km) are passable year round; both of these cities are major market centers in southwest Chad. Most of the secondary roads and tracks radiating from Sarh and Bongor as well as N'Djamena are subject to flooding. The road from N'Djamena to the primary market center in eastern Chad, Abeche, is in poor condition and is impassible during the flood season. Products destined for Abeche should be delivered prior to the rainy season. The road from N'Djamena to Moundou is also susceptible to flooding. Although the transportation is generally viewed as inadequate due to poor, insufficiently maintained roads, and seasonal variations of water transport, the network appears to be sufficiently extensive to access the most populous areas. As in all of the Sahelian countries, there exists a definite need in Chad for upgrading as well as maintaining the current infrastructure and additional attention

Table 30. Estimated Distribution Cost for Fertilizer Channeled to Key Market Areas, Chad

From	To	Mode	Distance	Distribution Cost[a]
			km	$/mt
N'Djamena	Abeche	Road	762	56.07
N'Djamena	Sarh	Road	559	42.16
N'Djamena	Bongor	Road	240	20.25
N'Djamena	Moundou	Road	477	36.53
Sarh	Moundou	Road	299	24.30
Sarh	Am-Timan	Road	357	28.29

[a]Includes handling.

must be placed on reducing the time factor in physical distribution.

Water transportation is possible on Lake Chad and the Chari River during the rainy season. Although this mode accounts for only 5% of Chad's domestic traffic, water transportation may be of particular value in complementing the road system during the rainy season. The Chari River is navigable from Lake Chad to Sarh during the rainy season.

Estimated costs of distributing bagged fertilizers among key market centers in Chad are shown in table 30. Costs range from $20 to $56/mt.

ALTERNATE SUPPLY SCHEMES

Given a 1976 consumption of mixed fertilizer (21-18-14-5S-0.6B) for cotton of 11,000 mt/year and projections for a total consumption of 20,000 mt of mixed grades by 1980 and 30,000 mt by 1985, establishing a bulk-blending plant in Chad appears feasible.

A simple bulk-blending scheme based on semi-bulk imports would seem to be best suited to Chadian conditions (see figures 1-5). Such a facility would contain a 3-mt mixer and equipment capable of producing 12 mt/hour. Variations in annual rate would be obtained by simply varying the number of hours operated.

Raw materials would be imported via Douala in 1-mt, semi-bulk containers and shipped by rail and truck or solely by truck to the blending facility. Materials could be stored in the containers at the facility and transferred to small bins with a forklift. A small payloader would transfer materials from the bins to the blending system. Then, the blended material would be transferred to a small mechanical bagger and then to the truck loading dock. The entire operation could be under a shed, in an existing building, or even outside if operated only during the dry season. This very simple operation would

require an estimated capital investment of about $172,000.

Although a feasibility study is needed to determine the optimum location for the facility, estimations were made of the raw materials and operating costs for a plant in N'Djamena producing 12,000 mt/yr of the 21-18-14-5S-0.6B cotton mixture. A summary of the calculations is given in table 31. The production cost at N'Djamena, allowing for a 20% return on investment, is estimated to be $299/mt. The delivered cost at Sarh would be $341/mt. Costs would be somewhat less if the facility were located in the southeastern section of the country. For comparison purposes, the selling price for same grade in the 1976/77 season is about $427 at Sarh or $86 higher than the estimated costs using the proposed scheme.

Based upon the projected need for 22,000 mt (table 25) of mixed fertilizers in 1980 and the potential savings of $86/mt, Chad could save

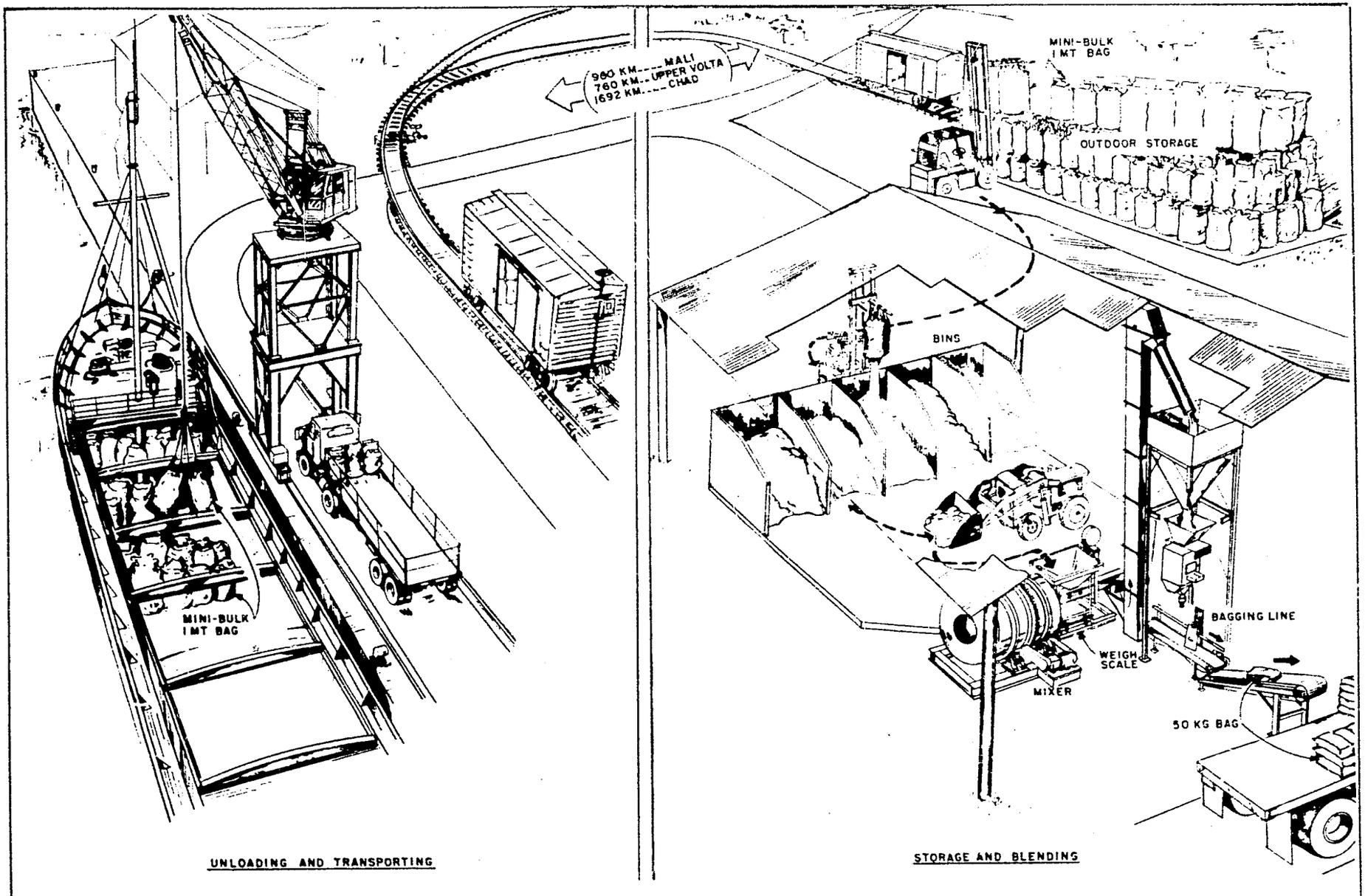
Table 31. Bulk Blending in Chad

Investment and Production Costs for 21-18-14-5S-0.6B Grade Mixed and Bagged in N'Djamena, Chad

Plant Location: N'Djamena
Operating rate, mt/year: 12,000
Investment: $172,000
Working Capital (cost of 1/2 of annual prod.): $1,700,000
Grade: 21-18-14-5S-0.6B

Raw Materials	mt/mt of Product	$/m
18-46-0 @ $281.28	.391	109.[illegible]
Potassium sulfate @ $228.85	.259	59.[illegible]
Urea @ $253.28	.304	77.[illegible]
Borax @ 332.85	.053	17.[illegible]
Subtotal		263.[illegible]

Fixed and Variable Costs	$/mt
Electricity, gasoline, etc.	0.15
Operating labor	0.70
Maintenance (5% of equipment cost)	0.53
Depreciation (15 years)	0.96
Taxes and insurance (2% of investment)	0.57
Supplies (20% of maintenance)	0.22
Overhead (100% of labor)	0.70
Interest (8.5% of 1/2 investment)	0.61
Bags	10.00
Product loss (2% of raw materials)	5.28
Subtotal	19.72
Interest on W.C. (8.5%)	12.04
Ex-Factory cost, with 20% ROI	295.65
Freight to Sarh	298.52
	42.16
Cost at Sarh with 20% ROI	340.68



BULK BLENDING SCHEME FOR
(1) UPPER VOLTA – MALI, (2) MALI, (3) UPPER VOLTA AND (4) CHAD

Figure 1.

Figure 2 Attaching Hooks to Bags in Ship's Hold

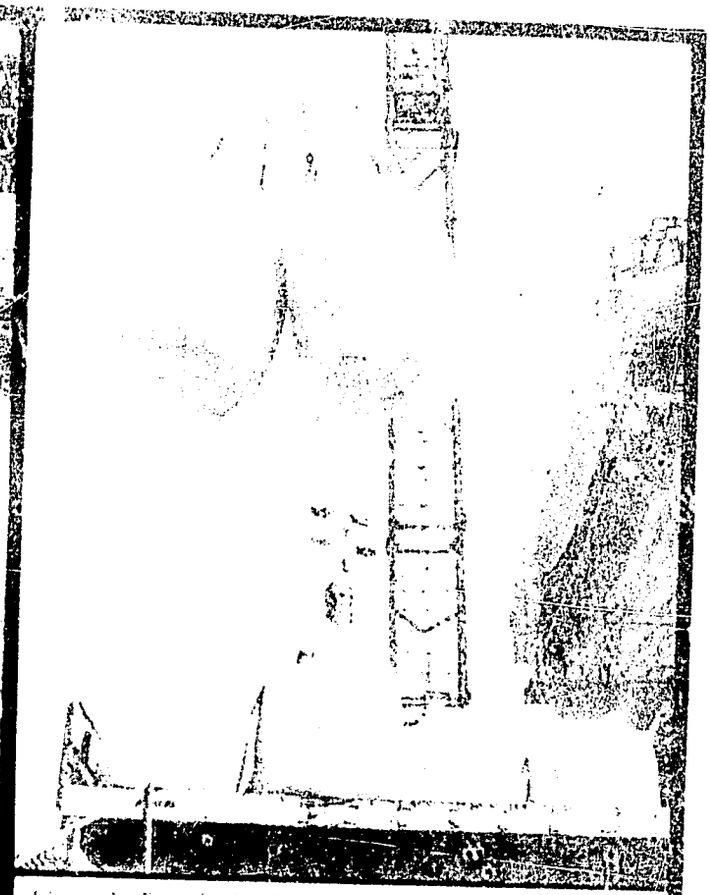


Figure 3 Transferring 1-mt Bags to Truck

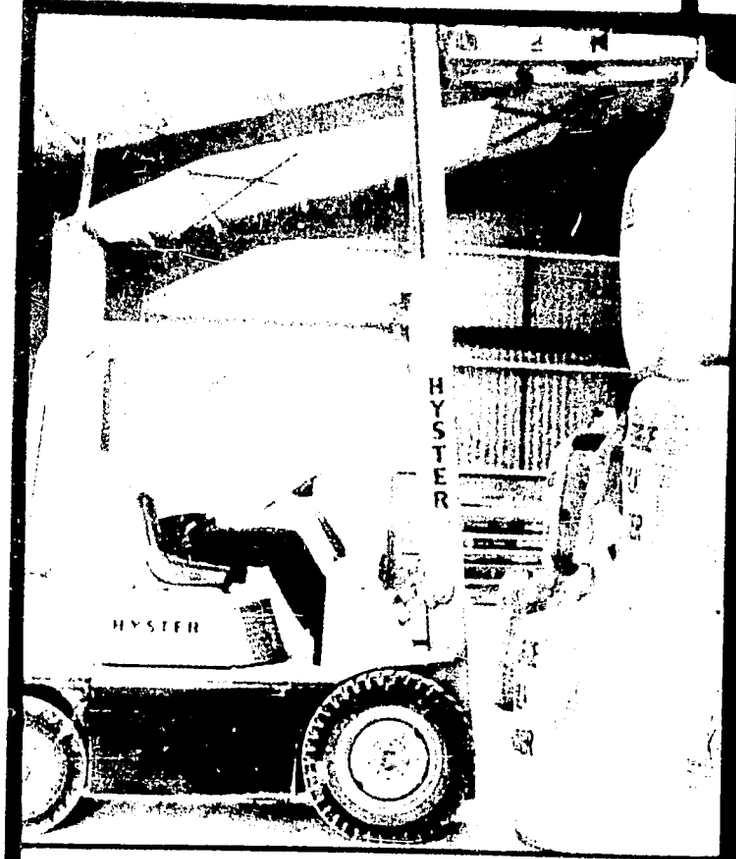


Figure 4 Stacking 1-mt Bags in Storage Area

Figure 5 Filling 1-mt Bags from Bulk Shipment

$1.9 million by establishing the blending facility described. Foreign exchange savings would be even greater since estimated delivered material costs would be $264/mt vs. $427 for mixed grades presently imported. Thus, the foreign exchange savings of $163/mt would be $3.6 million in 1980, based on imports of 22,000 mt of material.

POTENTIAL PROJECTS

The use of mineral fertilizers on cotton and on a number of other crops readily finding a market, at least up to a certain level, appears to be economical for the farmer. On staple food crops the current economics of fertilizer use pose serious constraints to increased use.

Several potential projects were identified which, if implemented within a total resource development program, could lead to increased agricultural development in Chad. In the area of general agricultural research and extension, it is recommended that the following projects be developed.

1. Strengthening of applied research to develop extension themes for various technology levels based to the greatest extent possible on the exchange of experience obtained in other parts of the ecological zone.

A. Determination of appropriate varieties--mainly of millet, sorghum, and peanuts--to increase yields with and without the use of fertilizers.

B. Determination of appropriate plant associations and rotations, including the increased cultivation of legumes, and investigations into the possibilities for legume inoculation and the addition of organic matter to the soil.

C. Determination of a solution about the symbiotic weed Striga lutea that has become a serious problem for millet/sorghum production.

D. Investigation into the possibility to recycle urban wastes for the use in horticulture around sizable towns, especially the capital.

2. Strengthening the agricultural extension activities concerning quality and equipment and bringing them efficiently to the field, mainly through the intermediate action of pilot/model farmers.

3. Supplementing statistical information on agriculture. The possible use of the LANDSAT satellite information system should be investigated.

Potential projects more directly related to increased crop production through efficient use of fertilizers are concerned with: (a) public policy on price stabilization and equalization; (b) determination of explicit effects of fertilizers under farmer conditions for both the immediate and succeeding crops; (c) establishment of bulk-blending facilities in Chad; and (d) exploration of Bahr-er-Ghazal to determine if phosphate rock deposits exist. A summary of projects dealing with the first three items follows and more detailed statements appear in appendix III.

Soil Fertility Project

A fertilizer trial and demonstration program is needed in Chad to obtain data and demonstrate response for major crops at various levels of on-farm management. Method of land preparation and tillage, varieties, plant population, timing of seeding, weeding and harvesting, and soil type and moisture need to be correlated with crop response to fertilizer. Research findings can then be incorporated into an extension education and demonstration program which can advise farmers on new production practices.

IFDC recommends that an expatriate team of crop production specialists be assigned to Chad to work closely with existing research and extension organizations to obtain crop response data and demonstrate responses to farmers. Project team members would be responsible for agronomic and economic research on crop response and for training nationals in methods of agricultural research and extension education. The term of the project is 5 years.

Bulk Blending of Fertilizers

Chad is currently importing about 11,000 mt/year of mixed fertilizer materials. A simple low technology type of bulk-blending facility could be used to supply needed NPK mixtures at a lower cost than imported finished fertilizers.

IFDC recommends the installation of a bulk-blending facility at a suitable location yet to be determined. Raw materials would be shipped to Douala in semi-bulk 1-mt containers and then transported to a storage-blending facility in Chad. The recommended bulk-blending and bagging operation has a capacity of producing 12 mt/hour (see figures 1-5).

IFDC recommends an expatriate team consisting of a mechanical engineer and a chemical engineer to work with Chadian counterparts in planning a system to handle 1-mt containers from port to plant site, design plant layout, and write equipment specifications. The consulting engineers would then assist Chadian engineers in initial assembly and startup activities. The term of the project is 1 year.

Public Policy Studies on Price Stabilization and Equalization

Fertilizer use is highly dependent upon the relationship between the cost of fertilizer and crop prices.

IFDC recommends that alternate public policies on price support and cost subsidization be studied to determine their effects on fertilizer adoption, food production, and overall economic development. IFDC recommends that one expatriate economist work with Chadian economists from the appropriate planning organization to carry out the study. The term of this project is 6 months.

Estimated Budgets

The estimated foreign exchange requirements for the budgets for the recommended projects are:

Project	Period, Years	Budget
Soil Fertility	5.0	$1,950,000
Bulk Blending	1.0	293,000
Public Policy	0.5	31,000
PR Identification	0.5	75,000
Total		$2,349,000

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Table 1. Projections of Fertilizer Consumption on Cotton, 1978/79 to 1985/86

Year (Season)	Fertilized[a] Area, ha	Projected Fertilizer Consumption, mt				
		N	P_2O_5	K_2O	Total	19-12-19
1978/79	182,500	3,467	2,190	3,467	9,124	18,250
1979/80	200,000	3,800	2,400	3,800	10,000	20,000
1980/81	217,500	4,132	2,610	4,132	10,874	21,750
1981/82	235,000	4,465	2,820	4,465	11,750	23,500
1982/83	246,000	4,674	2,952	4,674	12,300	24,600
1983/84	257,000	4,883	3,084	4,883	12,850	25,700
1984/85	268,000	5,092	3,216	5,092	13,400	26,800
1985/86	279,000	5,301	3,348	5,301	13,950	27,900

[a]1978/79 to 1981/82 following ONDR projections, 1982/83 to 1985/86 assumption that annual increase of area under single dose is 50% of annual increase of area in the period 1978/79 to 1981/82, annual increase of area under double dose maintained as before. Area under double dose converted to hectares of single dose, reference figure 1981/82 (projected by ONDR).

Table 2. Projections of Fertilizer Consumption on Rice, 1978/79 to 1985/86

Year (Season)	Fertilized Area, ha	Projected Fertilizer Consumption, mt[a]						
		N	P_2O_5	K_2O	Total	Urea	15-15-15	Total
1978/79	1,000	60	30	30	120	100	200	300
1979/80	2,500	150	75	75	300	250	500	750
1980/81	4,500	270	135	135	540	450	900	1,350
1981/82	6,500	390	195	195	780	650	1,300	1,950
1982/83	7,300	438	219	219	876	730	1,460	2,190
1983/84	8,100	486	243	243	972	810	1,620	2,430
1984/85	8,900	534	267	267	1,068	890	1,780	2,670
1985/86	9,750	585	292	292	1,169	975	1,950	2,925

[a]Assumptions: covering SATEGUI-DERESSIA and Flood Plain Development Project; base figure for existing consumption estimated at 900 mt urea = 400 mt N; by 1981/82 50% of targeted area fertilized, by 1985/86, 75%; rate of fertilizer is 200 kg/ha of 15-15-15 plus 100 kg/ha of urea.

Table 3. Projections of Fertilizer Consumption on Wheat (Polders) 1978/79 to 1985/86

Year (Seasons)	Fertilized Area, ha	Projected Fertilizer Consumption, mt[a]						
		N	P_2O_5	K_2O	Total	Urea	DAP	Total Material
1978/79	100	5	5		10	5	10	15
1979/80	200	9	9		18	10	20	20
1980/81	400	18	18		36	20	40	60
1981/82	600	27	27		54	30	60	90
1982/83	675	30	30		60	34	68	102
1983/84	750	34	34		68	38	76	114
1984/85	825	37	37		74	41	82	123
1985/86	900	40	40		80	45	90	135

[a]Assumptions: by 1981/82, 50% of targeted area fertilized, by 1985/86, 75%; fertilizer rate of 100 kg/ha of diammonium phosphate plus 50 kg/ha of urea.

Table 4. Projections of Fertilizer Consumption on Cereals/Small Scale Irrigation Projects--1978/79 to 1985/86

Year (Season)	Fertilized Area, ha	Projected Fertilizer Consumption, mt[a]						
		N	P_2O_5	K_2O	Total	Urea	15-15-15	Total Material
1978/79	100	6	3	3	12	5	20	25
1979/80	200	12	6	6	24	10	40	50
1980/81	300	18	9	9	36	15	60	75
1981/82	500	30	15	15	60	25	100	125
1982/83	560	34	17	17	68	28	112	140
1983/84	620	37	19	19	75	31	124	155
1984/85	680	41	21	21	83	34	136	170
1985/86	750	45	23	23	91	38	150	188

[a]Assumptions: by 1981/82, 50% of targeted area fertilized, by 1985/86, 75%; fertilizer rate of 200 kg/ha of 15-15-15 and 50 kg/ha of urea.

Table 5. Projections of Fertilizer Consumption on Sugarcane 1978/79 to 1985/86

Year (Season)	Fertilized Area, ha	Projected Fertilizer Consumption, mt[a]							
		N	P_2O_5	K_2O	Total	Urea	DAP	MP	Total Material
1978/79	100	15	8	10	33	27	17	17	61
1979/80	400	60	32	40	132	108	68	68	244
1980/81	900	135	72	90	297	243	153	153	549
1981/82	1,700	255	136	170	561	459	289	289	1,037
1982/83	1,900	285	152	190	627	513	323	323	1,159
1983/84	2,100	315	168	210	693	567	357	357	1,281
1984/85	2,300	345	184	230	759	621	391	391	1,403
1985/86	2,500	375	200	250	825	675	425	425	1,675

[a]Assumptions: By 1981/82, 50% of targeted area fertilized, by 1985/86, 75%; fertilizer rate assumed as 270 kg/ha urea, 120 kg/ha diammonium phosphate, 170 kg/ha muriate of potash.

Table 6. Projections of Fertilizer Consumption on Peanuts (Southern Zone) 1978/79 to 1985/86

Year (Season)	Fertilized Area, ha	Projected Fertilizer Consumption, mt[a]							
		N	P_2O_5	K_2O	Total	Urea	DAP	TSP	Total Material
1978/79	500		11		11			25	25
1979/80	1,100		25		25			55	55
1980/81	1,800		40		40			90	90
1981/82	2,500		56		56			125	125
1982/83	2,800		63		63			140	140
1983/84	3,100		70		70			155	155
1984/85	3,400		77		77			170	170
1985/86	3,700		83		83			185	185

[a]Assumptions: By 1981/82, 50% of targeted area fertilized, by 1985/86, 75%; fertilizer rate of 50 kg/ha triple superphosphate.

APPENDIX II

Fertilizer Raw Material Deposits

CHAD

References	Composition of Samples	Location	Other Information
Statistics of the Societe de l'Industrie Minerale, Nov. 1975, p. 504, and a private communication from the Direction des Mines et de la Geologie, Republique du Tchad.	Trona (Impurities are not mentioned but mainly chlorides)	Chad Production on the shoes and islands of Lake Chad accounts for much of the output.	Year ... Production (tons) 1970 ... 3,800 1971 ... 3,800 1972 ... 1,400 1973 ... 1,100 1974 ... 2,400 The trona is produced in slabs weighing 15-30 kg each under the control of SONACOT, a state company. More trona than the totals mentioned is produced for local use. The bulk of the trona is exported. Trona is recovered after the rainy season of July-Sept., when Lake Chad begins to dry up. Laborers dig into the still-wet shores to a depth of about 1-1/2 meters for the mineral. The products (slab and crushed trona are sun-dried and marketed.
Private communication	Brines	East and South of Fort Lamy	It is believed these contain alkali as well as chlorides.
Private communication	Oil There is a 2,000 tpy oil refinery (in 1970) run by BECHE Oil Company.)	I Miandoum	Discovered Sept. 1974, first 3 wells dry, last 2 holes show oil. This is the CONOCO find, no doubt, described elsewhere as being near Rig-Rig.

CHAD (Continued)

References	Composition of Samples	Location	Other Information
Private Communication	Brines	Near Garoua and Rei-Bouba	Said to be many occurrences.
Bull Soc. fr. Min. 1968, 91, 388-395. Proc. Conf. Afr. Geol. 1972, p. 413-426. C. Rend. Paris 1974, 2790, 377-9. (All by G. F. Maglinoe)	Trona, $NaHCO_3 \cdot Na_2CO_3 \cdot 2H_2O$	Kanem Region	This series of papers describes how the solid salts arise by capillary evaporation from shallow alkaline ground waters. A map in the first paper shows the trona areas and the small section being worked commercially. The deposits lie between 13-1/2°-15-1/2°E and 13° and 14-1/2°N. In the deposits the significant impurities are potassium, silicate, and chloride. But the (Na + K)Cl ratio for most samples is between 4 and 12 showing that the deposits are substantially sodium carbonate and bicarbonate.
	Natron, $Na_2CO_3 \cdot 10H_2O$	Mainly between Liwa and Kaya.	
	Nacholite, $NaHCO_3$		
	Gaylussite, $CaCO_3 \cdot Na_2CO_3 \cdot 2H_2O$		
	Thermonatrite, $NaCO_3 \cdot H_2O$		
	Northupite, $Na_2CO_3 \cdot MgCO_3 \cdot NaCl$		

APPENDIX III

Recommended Projects

SOIL FERTILITY PROJECT IN CHAD

Fiscal year proposed for financing: FY 1978

Priority and Relevance

A goal of AID support in west Africa is to assist in increasing food production, particularly to restore balance between production and demand. Major emphasis is being placed on this goal by AID through support of Semi-Arid Food Grain Research and Development (SAFGRAD) and country and sectional crop production and/or integrated rural development projects.

Requirements for millet and sorghum, primary food crops, are projected to increase 105,000 and 210,000 mt by 1980 and 1985 over 1975 food requirements. To help meet these needs, several productivity projects have been implemented. These programs are much needed and are essential to bring about improved crop production. In addition, other measures are needed to improve crop yields and expand production.

Experiment station and farm level information is scarce for cereal response to fertilizer in Chad. Based upon data from other countries, the expected on-farm response to low levels of application may be from 7 to 15 kg of grain/kg of N plus P_2O_5. To maximize the response to fertilizer, improved production practices at the farm level must be implemented. Little is known about farmer attitudes toward acceptance of improved cultural practices. Efforts have been made to introduce changes without much success. The lack of widespread acceptance in many cases may be due to the lack of farmer knowledge, bottlenecks in the delivery system for inputs, limited availability of credit at economical interest rates, inadequate input/output price relationships, and unstable market demand.

Description of Project

This project would implement a soil fertility program in Chad consisting of two "action" components followed by a project evaluation. The term of the project is 5 years. It would be implemented within the framework of existing institutions responsible for agricultural research and extension.

The objectives of the soil fertility project are:

1. Define the nature of response (both immediate and residual) of food crops to fertilizer in various soil and climatic conditions at the farm level;
2. Train nationals in improved crop production practices, methods of conducting and analyzing trials and demonstrations, and using results with farmers;
3. Demonstrate to farmers the value of improved crop production practices; and
4. Relate levels of inputs of a crop production program to outputs, changes in attitudes, and changes in practices.

This project proposes that one crop production specialist be assigned to work in each of four regions with one production economist stationed at N'Djamena. One of the persons assigned to N'Djamena would be coordinator. Each crop specialist would have four and the economic specialist two assistants (nationals) that would be trained to carry on the work themselves. One or two additional new assistants would be added each year.

Specialists would be assigned for 2 and 3 years and rotation would be staggered to permit continuity. The first coordinator's term would be for 3 years. The specialists must have training and experience to conduct professional levels of work and must be able to effectively converse in French. Specialists should arrive in Chad in January or February to give time for familiarization and planning before their first crop season. Upon arrival, the specialists would familiarize themselves with crop production programs including research, extension, and input and output marketing, and make detailed plans for the coming season in consultation with appropriate personnel from other organizations.

Each crop specialist would be responsible for conducting 30 to 40 crop production trials or demonstrations of a design suitable to measure the effect of individual plant nutrients, crop variety, plant population, timing of planting and harvesting, soil preparation, and incorporation of residue or manure application. Long-term experiments would be established to determine the effect of crop rotations and the value of residual fertilizer.

In all trials and demonstrations, soil samples would be obtained and analyzed for attempts at correlation of yield response and levels of soil test P and possibly other characteristics. Arrangements would be made for proper analysis of samples at research station laboratories. Rainfall (quantity and distribution) would be recorded at or near each location.

The economist would coordinate statistical and economic analyses of project results, develop practical farm budgets for various cropping and economic situations, and serve as field advisor for a graduate student conducting adoption studies of changes resulting from crop production program.

The study by the graduate student would include documenting at the village level such things as: kinds and number of farmer contacts; availability of credit and other inputs; input and output prices; price fluctuations; availability of markets; acceptance and implementation of new practices; and effect of these on production, labor requirements, and economic well-being. The study would attempt to define the relative importance of various inputs of a crop production program upon the diffusion, acceptance, and implementation of improved cropping practices.

Training sessions would be conducted with assistants covering how and why various things are done. In addition, training sessions would be held with each cooperating farmer before trials are established, during the growing season, during harvest, and after harvest.

AID and Other Relevant Experiences

AID has funded many applied research, crop production, and extension training projects. The soil fertility project has particular relevance to the SAFGRAD project since it contains an action program to strengthen national institutions and to provide immediate benefits to Chadian farmers.

Beneficiary

Principal beneficiaries of the project are Chadian farmers. Through better defined crop response data and better informed extension advisors, farmers are more likely to increase crop yields and produce more for the time spent for production.

Feasibility Issues

Present farmer price for 50 kg of urea (23 kg of nutrients) in Chad is 2,500 F CFA. If a response of 10 kg of grain/kg of nutrient is obtained, the yield increase is 230 kg/ha. Using 15 F CFA/kg as the grain price, the value of the increased yield is 3,450 F CFA/ha or 950 F CFA/ha above fertilizer cost.

On the national basis, fertilizing 10,000 ha of millet or sorghum would require 230 mt of nutrients and result in 2,300 mt of additional grain. Estimated economic farmgate value of sorghum based upon world prices, margins, and freight is 48,600 F CFA/mt which gives an economic farmgate value of 112 million F CFA for the additional grain produced from 230 mt of nutrients. These nutrients supplied as urea would cost 28.8 million F CFA delivered to N'Djamena (based upon estimated cost/mt in 1976). Using the same rate for domestic freight and margins as for grain, these add 3.1 million F CFA for a total cost of 31.9 million F CFA for the fertilizer delivered to farms. Therefore, each million F CFA spent on fertilizer can yield grain to replace 3.5 million F CFA in grain imports.

Other Donor Coordination

International Bank for Reconstruction and Development (IBRD), Fonds Europeen de Developpement (FED), Fonds d'Aide et de Cooperation (FAC), United Nations Development Program (UNDP), and AID are presently funding crop production projects and/or research and extension activities. The Federal Republic of Germany, Canadian International Development Association (CIDA), and Ford Foundation may be interested in funding for this type of project.

Financial Plan

The annual foreign exchange cost of the project is estimated to be $390,000 or $1.95 million for a 5-year period. In addition, the GOC would be expected to supply the assistants and field hands for the work as well as office space. It is estimated that about 60% of the salaries budgeted in the first year for technical services would be needed in the first year since they will not be in the field a full year in the first fiscal year. However, support costs will be highest the first year.

Estimated Foreign Exchange Support for Five-Year Project

Technical Services

Crop Production Specialists--4 at $45,000 x 5	$ 900,000
Production Economics Specialist--at $45,000 x 5	225,000
Support	625,000
	$1,750,000

Graduate Student Stipend--1 at $3,000 x 2	6,000
Support--$17,000 x 2	34,000
Travel--$5,000 x 2	10,000
	$ 50,000
Commodities	50,000
Travel for Specialists, Workshops, Printing, and Logistic Support	100,000
Grand Total	$1,950,000

Implementation Plan

A contractual agreement will be made with GOC. The project would be administered by a project coordinator probably placed in the administration of MEAE. Very close collaboration would be needed with the managements of all productivity projects and other ministries dealing with agricultural production.

Project Development Schedule

Departure, Project Design Team	January 1, 1978
Project Committee Review, Project Paper	April 1, 1978
Review/Approval of Project Paper	June 1, 1978
Project Staff Arrive in Chad	January 1, 1979

BULK BLENDING OF FERTILIZERS, CHAD

Fiscal year proposed for financing: FY 1978

Priority and Relevance

Chad is currently using about 11,000 mt/year of mixed fertilizers. All of this requirement is imported as finished materials. A simple low-technology type of bulk-blending facility could be used to provide the NPK mixtures needed in Chad at lower costs than the imported finished goods.

Description of Project

Raw materials such as diammonium phosphate, ammonium sulfate, and potassium chloride would be imported at Douala in semi-bulk, 1-mt containers. The containers would be shipped to Chad either directly by truck or by rail-truck. The raw materials would be stored in the containers and fed into a simple bulk-blending, bagging operation capable of producing 12 mt/hour.

AID and Other Relevant Experience

The classical approach to bulk blending is to receive raw materials in bulk into a bulk storage and handling facility. For this project, raw materials would be received in 1-mt disposable containers which would eliminate the need for expensive bulk handling and storage facilities.

Beneficiary

Timely arrival of cheaper fertilizers would benefit the small farmers and lead to increased crop production. Establishment of a bulk-blending facility would also provide an excellent starting point for future extension of industrial fertilizer activities.

Feasibility Issues

Calculations of the cost of producing 12,000 mt/year of a 21-18-14-5S-0.6B grade at N'Djamena are summarized in table 31. Allowing for a 20% return on investment, the ex-factory cost is estimated to be approximately $299/mt or $341/mt delivered to Sarh. For comparison purposes, the current delivered cost of the same grade at Sarh is about $427/mt or a difference of $86. It is evident that a bulk-blending facility to produce mixed grades for Chad can be justified.

Other Donor Coordination

Fonds Europeen de Developpement (FED) and the Democratic Republic of Germany have shown interest in fertilizer facilities in other Sahelian countries and might be interested in participating in this project.

Financial Plan

Capital investment required for the facility has been estimated at $172,000. This estimate includes machinery, freight on machinery, spare parts, concrete pads, foundations, and installation. Land and building costs have not been included. In addition, technical expertise will be required to help with the following:

1. Work out details of importing and handling the 1-mt containers.
2. Choose site for location of the equipment.
3. Assist in design of the plant layout and writing specifications for the equipment.
4. Assist in evaluating equipment bids and expediting purchase of equipment.
5. Prepare operating instructions for the facility.
6. Startup of the facility.

Following is an estimate of manpower and associated costs for performing these functions:

Estimated Foreign Exchange Financial Support for One-Year Period

Capital Investment	$172,000
Preinvestment Study	18,000
Technical Services	
Chemical Engineer--1 at $40,000/year x 0.7	28,000
Mechanical Engineer--1 at $40,000/year x 0.3	12,000
Support	30,000
Subtotal	$ 70,000

Training	
Specialty--3 at $100/day x 90	27,000
Travel--3 at $2,000 each	6,000
Subtotal	$ 33,000
Grand Total	$293,000

Implementation Plan

A two-man team consisting of one chemical engineer and one mechanical engineer should visit Chad for 4 weeks to assist in working out details for handling the 1-mt containers. A plant site must be chosen followed by design of plant layout, and writing equipment specifications. Two Chadians should be provided as counterparts to the team. The two counterparts selected should be the two key persons chosen to operate the facility when built. One should be familiar with operation of mechanical equipment and the other with importation and shipping of goods in Chad.

Subsequent visits of the consulting engineers should coincide with the arrival and assembly of equipment, receiving of raw materials, and startup of the facilities.

It is not clear into what institutional framework the bulk-blending operation will be placed. Possibly an agricultural supply organization should be considered for the operation of the bulk-blending facility as well as handling other farm inputs.

Project Development Schedule

Choice of Chadian counterparts and arrangement for team visit	January 1, 1978
Initial team study plus final preparation of project details and specifications	March 1, 1978
Bid invitations and bid evaluation	May 1, 1978
Equipment fabrication	July 1, 1978
Equipment delivery	October 1, 1978
Erection and startup	February 1, 1979

STUDY OF PUBLIC POLICIES ON PRICE STABILIZATION AND EQUALIZATION

Fiscal year proposed for financing: 1978

Priority and Relevance

Fertilizer use level is highly dependent upon the cost-price relationship between fertilizer and a crop although other factors influence fertilizer use. Farmers tend to maximize net returns and do not use fertilizer if returns do not cover the cost plus risks involved.

Generally, a kg of nutrient can be expected to give 8 to 10 kg of cereal grain. At current world prices for grain and fertilizer nutrients, imports of grain would cost 2 times the cost of fertilizer to produce the grain in Chad. An in-depth analysis would require consideration of many other factors.

Description of Project

This study would describe alternative public policies on price stabilization and equalization; subsidies for crops, fertilizers, and other related inputs; their implementation; effects upon fertilizer use; and the effects on the economy of the country sectors and regions. It would furnish guidelines for establishing policies related to fertilizer use which could effectively meet government goals. The study would require one expatriate economist working with one or more economists from the national planning agency. The study would be completed in 6 months.

AID and Other Relevant Experience

The nature of other studies in this area financed by AID is unknown.

Beneficiary

Agricultural development would benefit rural and urban sectors. Increasing self-sufficiency in food through appropriate agricultural price and incentive policies would substantially strengthen Chad's international position by helping to correct current balance of payment problems.

Feasibility Issues

Establishing favorable fertilizer product prices could result in increased fertilizer use and increased food crop production provided other inputs are available for favorable response of crops to fertilizer. Given the varying cost:price ratios over the years it would seem worthy of establishing guidelines.

Other Donor Coordination

Unknown.

Financial Plan

The foreign exchange cost of the study is estimated to be $31,000. In addition, the local government would be expected to supply one or two local economists to work on the project.

Estimated Foreign Exchange Support for the Study

Technical Services	
Economist--1 at $30,000 x 0.5	$15,000
Support	10,000
Travel	5,000
Publication	1,000
	$31,000

Implementation Plan

A contractual agreement would be made with the GOC. The study would be undertaken with the national planning agency. It would require cooperation and assistance from other ministries and organizations responsible for marketing agricultural inputs and outputs.

Project Development Schedule

Visit to the country for project negotiation	January 1, 1978
Visit to field for data gathering (2 months)	April 1, 1978
Completion of study	September 1, 1978