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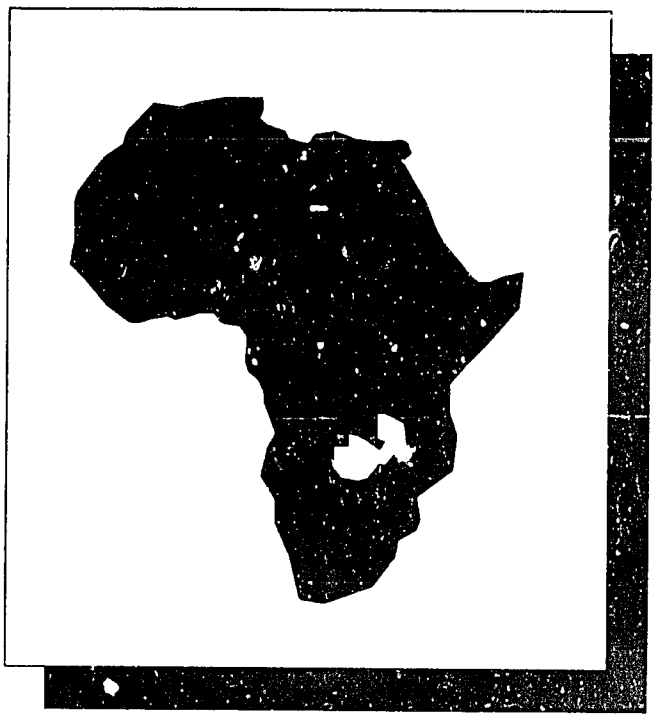

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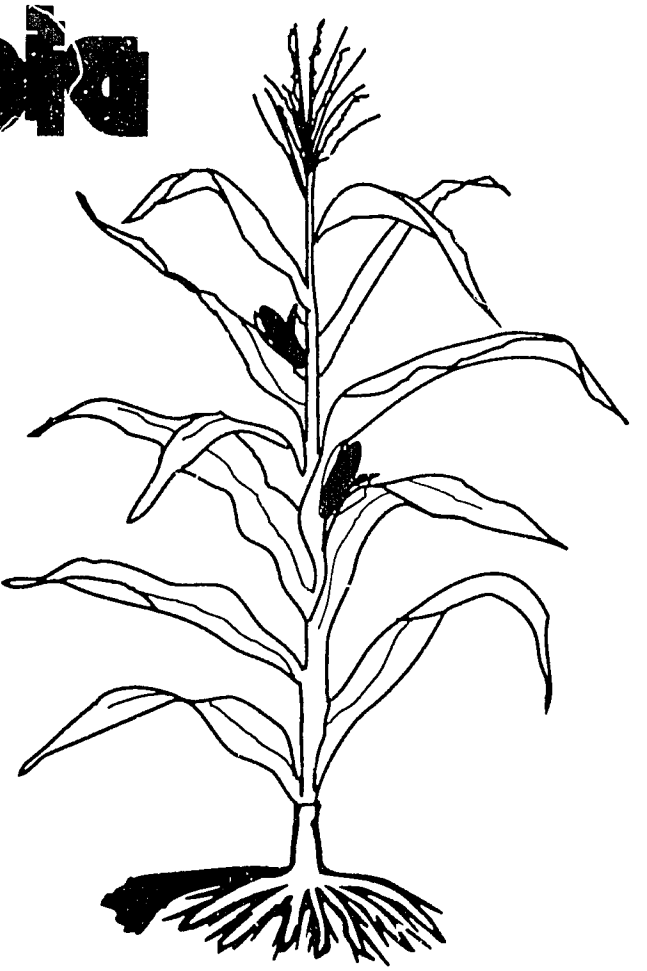

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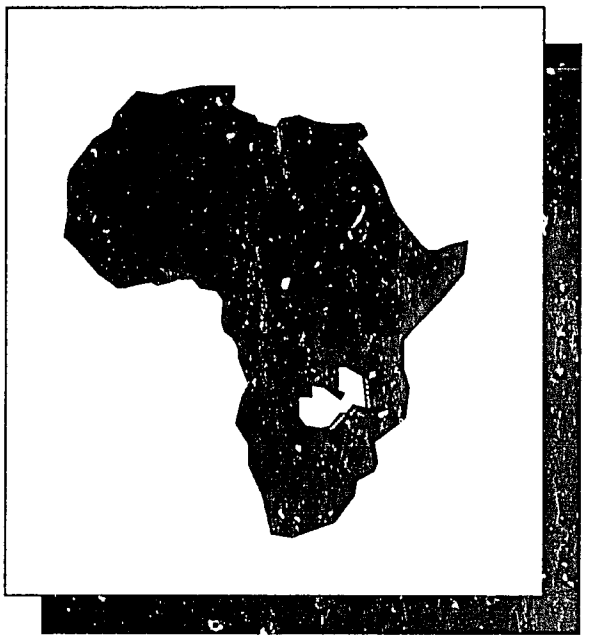

Fertilizer Situation and Markets in Zambia

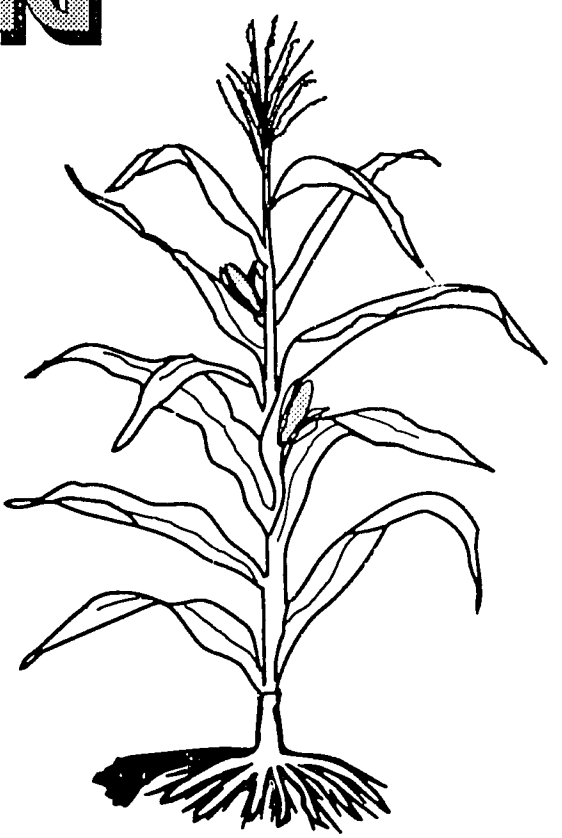

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Table of Contents

Page

Introduction .....
Geography .....
Cl[illegible] .....
[illegible] .....
[illegible] .....
[illegible] .....
[illegible] .....
[illegible] .....
[illegible] .....
[illegible] .....
[illegible] .....
[illegible] 7
[illegible] .....
Financial Incentive to Use Fertilizer .....
Fertilizer Marketing System .....
Government Involvement .....
Fertilizer Supply 12
Procurement 14
Physical Distribution 14
Pricing 17
Cost of Marketing 18
Credit 18
Fertilizer Recommendations .....
Fertilizer Research .....
Nitrogen 24
Phosphorus 24
Potassium 25
Soil Acidity, Calcium, and Magnesium .....
Micronutrients 25
Future Fertilizer Research 25
Extension Service 26
Fertilizer Raw Materials 27
Fertilizer Consumption Forecast 30
Concluding Comments 31
References 32

Abbreviations and Acronyms

Chemicals and Fertilizers

AN	ammonium nitrate
Ca	calcium
CAN	calcium ammonium nitrate
K_2O	potassium oxide
Mg	magnesium
N	nitrogen
P_2O_5	phosphate pentoxide
TSP	triple superphosphate

Measurements

kg	kilogram
km	kilometer
km^2	square kilometer
mm	millimeter
mt	metric ton
mtpy	metric tons per year
pH	Logarithm of the reciprocal of the hydrogen ion concentration in grams per liter; a solution of pH 7 is neutral

Miscellaneous

CCS	Cooperative Credit Scheme
CIDA	Canadian International Development Agency
c.i.f.	cost, insurance, and freight
DCU	District Cooperative Unions
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
K	Kwacha
LINTCO	Lint Company Limited
MINEX	Mineral Exploration Department
NAMBOARD	National Agricultural Marketing Board
NATCO	National Tobacco Company Limited
NCZ	Nitrogen Chemicals of Zambia Ltd.
PCMU	Provincial Cooperative Marketing Union
SADCC	Southern African Development Coordination Conference
SPRP	Soil Productivity Research Programme
VCR	value:cost ratio
ZAMSEED	Zambia Seed Corporation
ZCF	Zambia Cooperative Federation Ltd.
ZIMCO	Zambia Industrial and Mining Corporation Ltd.

Fertilizer Situation and Markets in Zambia

Introduction

Geography

The Republic of Zambia, with a population of 8.1 million, is a landlocked state in south-central Africa. Zambia is located between 10° and 20° latitude south and 20° and 30° longitude east of Greenwich.

The topography of Zambia is dominated by an uplifted planation surface. The highest elevations of 2,164 m are reached in the eastern part of the country on the Nyika plateau bordering Malawi. This plateau is associated with the famous East African Rift Valley system. Elevations gradually decline moving westward across Zambia (*1*).

The geological structure in the eastern, northern, and central regions is dominated by Precambrian sedimentary and metamorphic rocks with igneous intrusions exposed at the surface. In the north, Katanga rocks of upper-Precambrian age yield copper ores. The western one-third of Zambia is covered with wind-deposited sands of the Kalahari system. The Zaire Pedicle extending into the northern section of Zambia is the site of a continental divide that cuts across the northeast of Zambia to the Tanzania border.

Approximately 77% of Zambia is drained to the Indian Ocean by the Zambezi River and its two main tributaries, the Kafue and Luangwa Rivers. The remaining 23% is drained primarily to the Atlantic Ocean via the Chambishi and Luapula Rivers which flow into the Congo River that transverses Zaire (*1*).

Zambia is bordered by eight countries (Figure 1)—Namibia, Botswana, and Zimbabwe link with Zambia's southern border; Angola borders to the west; Tanzania and Zaire form the northern border; and Malawi and Mozambique lie to the east. Zambia has a land area of 752,614 km² (290,586 miles²) and is about the size of Mozambique, almost double the size of Zimbabwe, and about six times larger than Malawi. Having to depend upon neighbors for port facilities places Zambia at a considerable disadvantage in trade. Zambia's shortest route to the sea is through Zimbabwe to the Beira and Nacala ports in Mozambique. However, because of civil unrest, the Nacala route is not being used at this time. The main route used to import cargoes into Zambia is via the northern corridor through the port of Dar-es-Salaam, Tanzania. Lusaka is linked

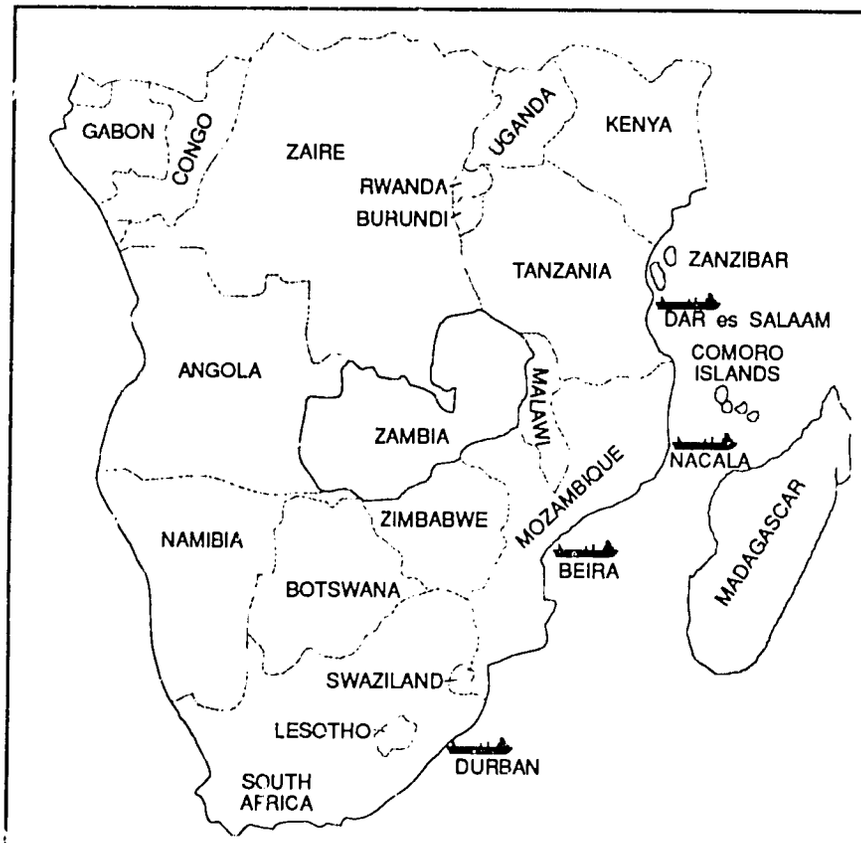


Figure 1. A Map of Zambia Indicating Neighboring Countries and Major Ports Serving Zambia.

Zambia terrain is well suited to crop production.

to the ports in Mozambique and Tanzania by rail. Zambia also imports some cargoes through the ports of Durban and East London in South Africa.

The capital of Zambia is Lusaka, which is located near the Kafue River in the southeastern portion of the country. In mid-1986, Lusaka's estimated population was 870,000. As shown in Figure 2, Zambia is divided into nine provinces. Lusaka is the smallest province, and it encompasses only the administrative area of the city. The Copperbelt Province has been a center of national activity due to production of copper and other minerals. A rail line extending south from the Copperbelt, through Lusaka, to Victoria Falls on the Zambezi River has been a major area of development.

Climate

Zambia has a favorable climate for a wide range of cultivated crops. The elevated plateau position and the southward movement of the equatorial low-pressure belt in the summer are the dominant controls on Zambia's climate. There are three distinct seasons in Zambia:

1. A warm-wet season, November-April, often referred to as the planting season.
2. A cool-dry season, April-August, the harvest season.
3. A hot-dry season, August-November.

Temperatures are generally moderate with a mean range of 30°-35°C. The coldest month has a range of 5°-10°C over most of Zambia. There can be frost in low-lying areas during this period. The

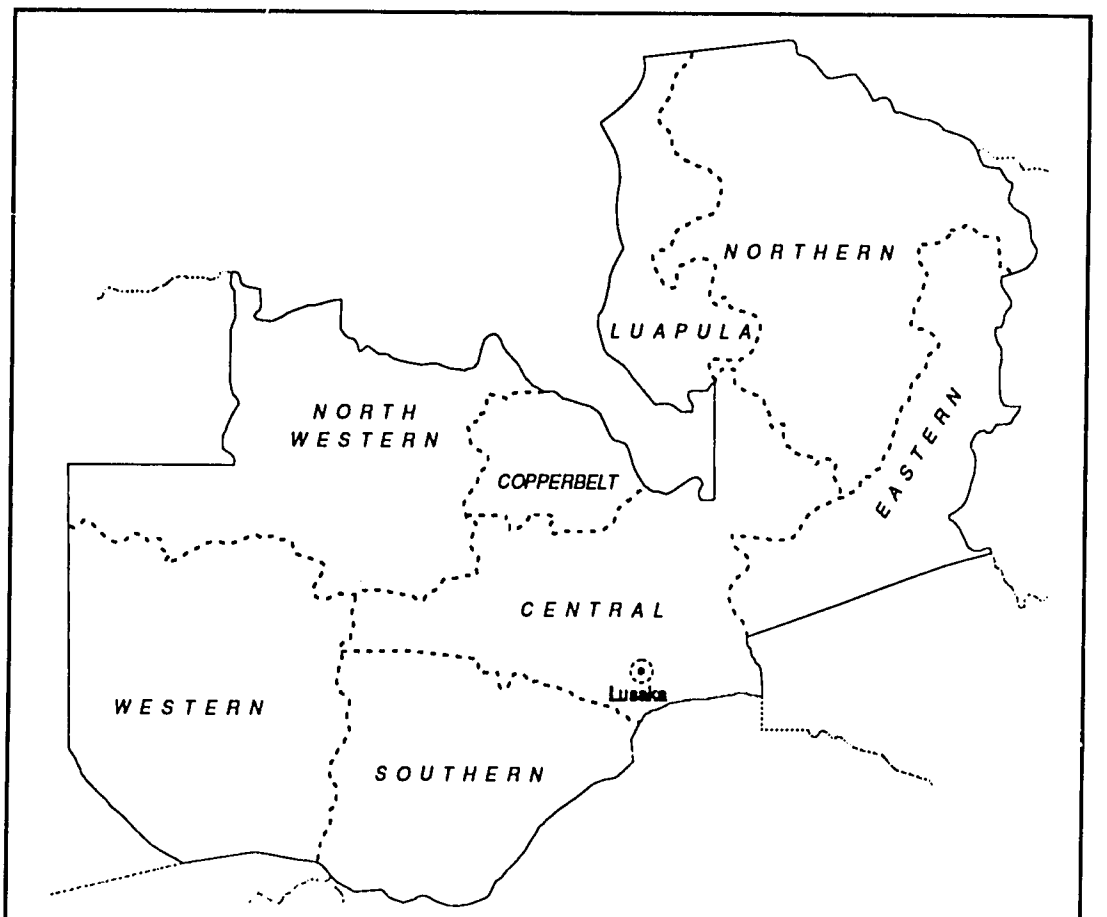


Figure 2. A Map Showing the Provinces of Zambia.

mean maximum temperature exceeds 35°C and can be found only in the southern portion of Zambia during the hot and dry season. Rainfall is greatest on the high plateau of the northern province and on the intercontinental divide west of the Copperbelt. In these areas, rainfall can exceed 1,200 mm/year. The southwest and the Zambezi Valley receive the lowest amount of rainfall; mean rates are less than 700 mm/year. Zambia does not have a truly arid area. Temperatures and precipitation for selected stations are presented in Table 1.

History

It is reported that ancestors of present-day Zambians probably arrived in the area about 2,000 years ago. The major waves of immigration began in the 15th century, and the influx was greatest in the 17th to 19th centuries. These Bantu-speaking immigrants came primarily from the Luba and Lunda tribes of southern Zaire and northern Angola but were joined by the Ngoni people from the south. They established in the areas they occupy today.

Until 1888, Zambia was ruled by African chiefs and the economy was based primarily on agriculture. Starting in 1889, a south African mining company in cooperation with the chiefs formed northern Rhodesia, which was later to become Zambia. In this period, copper mining and manufacturing provided a boom to the agricultural economy. In 1953 northern Rhodesia joined with southern Rhodesia and Nepasaland (now Malawi) to form the Central African Federation; in 1964 northern Rhodesia became Zambia, and Dr. Kenneth David Kaunda was elected their first and only president.

Table 1. Average Precipitation (mm) and Temperature (°C) for Selected Stations in Zambia, by Month

Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Solwezi													
Precipitation	294	236	240	65	4	0	0	1	1	51	193	283	1,368
Temperature	19.8	20.0	20.0	19.0	16.5	14.7	14.7	17.3	19.7	21.7	20.3	19.6	18.6
Kawambwa													
Precipitation	212	200	226	120	22	1	0	0	12	77	179	237	1,286
Temperature	21.1	21.3	21.3	20.3	19.5	18.1	17.7	19.8	22.5	22.5	20.5	20.0	20.4
Mwinelunga													
Precipitation	237	208	257	84	8	1	0	1	15	94	217	255	1,377
Temperature	19.7	19.7	19.8	19.7	17.8	15.6	15.7	18.3	21.3	21.3	19.6	19.6	19.0
Kasempa													
Precipitation	278	221	172	33	1	1	0	0	4	33	155	258	1,156
Temperature	20.6	20.7	20.6	20.1	17.6	15.2	15.5	18.2	21.7	23.2	21.5	221.1	19.7
Kafue Polder													
Precipitation	197	149	55	18	6	0	0	0	2	15	85	250	777
Temperature	22.2	22.1	21.6	20.6	18.2	16.0	16.0	18.2	21.8	24.7	23.7	22.6	20.6
Lusaka													
Precipitation	215	175	111	15	2	0	0	0	0	13	85	188	804
Temperature	20.5	20.3	20.1	19.6	17.5	15.5	15.5	18.0	21.2	24.1	22.3	21.0	19.6
Choma													
Precipitation	200	185	80	23	6	6	0	0	1	22	93	209	825
Temperature	20.6	20.5	19.8	18.5	15.2	12.8	12.5	15.0	19.1	22.0	21.7	21.0	18.2

Source: Food and Agriculture Organization of the United Nations (FAO).

One-half of the Zambia population is under 15 years of age.

Demography

Zambia's population in mid-1989 was estimated at 8.1 million, or slightly more than 1.2% of Africa's total 646 million people. Approximately one-half of Zambia's population is under 15 years of age; 3% of the people are over 65 years old. With an estimated annual growth rate of 3.7%, the population will reach 12 million by the turn of the century (*2*).

By African standards, Zambia has a low population density; at 0.1 person/ha of land or 10 ha of land for each individual, it is only 9.3 persons/km^2. By comparison, Malawi had a population density of 61.4 inhabitants/km^2 in 1986. Although the population density in Zambia is low, it can be misleading. Zambia is the third most urbanized country in black Africa, and approximately 78% of the urban dwellers reside in the 10 largest towns. Lusaka is the largest urban center in Zambia, having an estimated population in excess of 870,000; however, the towns in the Copperbelt constitute the largest concentration of urban population with slightly more than 75% of the total.

There are 73 different ethnic groups among the indigenous population in Zambia. The major groups include the Bemba tribe of the northeast and the dominant group in the Copperbelt; the Nyanja of the eastern province who are also numerous in Lusaka; the Tonga of the southern province; and the Lozi of the West. More than 80 languages are spoken in Zambia. English is the official, administrative language of the Government and provides a means of bridging communication gaps (*3*).

Zambia has 3,345 primary schools, 289 secondary schools, 14 teacher training colleges, 14 vocational and technical institutions, and 2 universities. Education is free in the primary and secondary schools. The students must provide their own stationery, and this is a barrier to many potential students. About 83% of Zambian children attend primary schools; 16% are educated in secondary schools and only 2% in institutions of higher education (*4*).

Economy

The Zambian currency is the Kwacha (K). Following 3 years of major devaluation, the official exchange rate at the beginning of 1991 was 1 K equals US $0.03 (K38.50 equals US $1.00).

Agriculture and the copper industry are the mainstays of the Zambian economy. Agriculture accounts for only about 12% of the country's gross domestic product (GDP) but provides employment for over 50% of the labor force. Meanwhile, in recent years the copper industry has accounted for over one-third of the GDP. In addition, over 90% of Zambia's export earnings are derived from the copper industry. Dependence upon a single

industry for export earnings places Zambia in a precarious economic position, as evidenced by developments of the past decade. For example, due to a severe erosion in international market prices for copper, the trade surplus of the mid-1970s has been replaced by an external debt estimated at more than US $5.5 billion in 1988. That is about three times more than the annual GDP. Copper prices firmed up slightly in 1989, and the mines continued to operate to earn much needed foreign exchange; however, economic pressure persists. The future of the Zambian economy is a major concern. It is estimated that, at the present rate of mining, the deposits of copper and cobalt will be depleted by the year 2005. Dependent upon imports for machinery and equipment, fuel, consumer goods, fertilizers, and even foodstuffs, the country is aggressively looking for ways to diversify the structure of its economic production. However, the small economic raw material base inevitably requires increased emphasis upon agriculture to meet the country's growing food requirements and to generate foreign exchange earnings.

Land Use

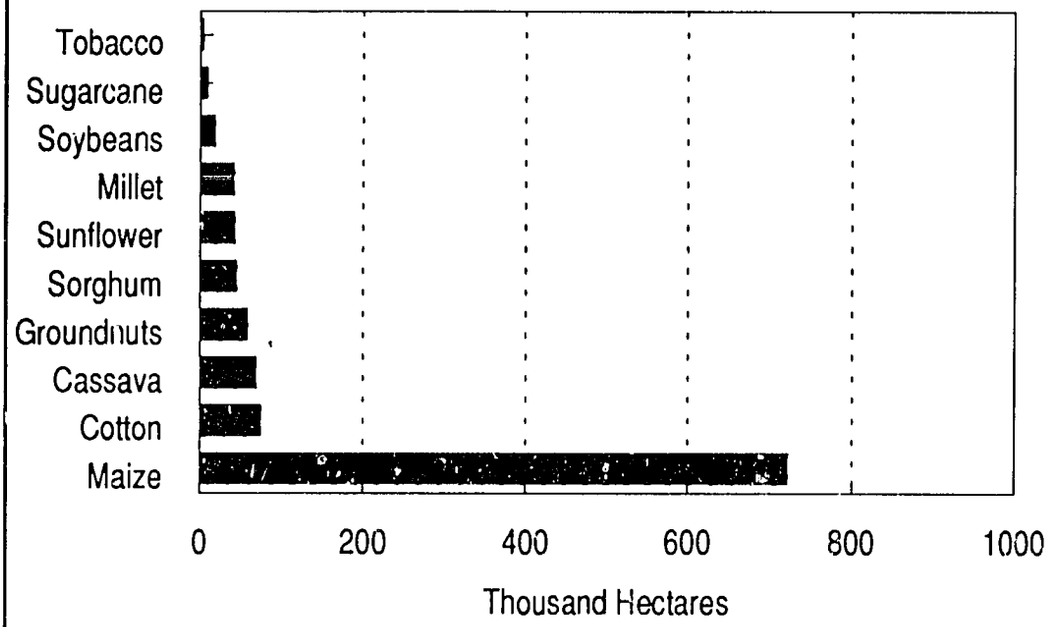
Zambia has a total land area of 74.07 million ha. Of the total land area, arable and permanent crops occupy 7%, permanent pastures 47%, and forest and woodlands 39% (*5*). Table 2 and Figure 3 show major agricultural use of land by crops grown in 1987 and 1988. Maize is the major crop grown in Zambia and constitutes a basic component of the diet. It accounted for over 60% of the total cropped area in 1988.

Table 2. Major Crops Grown in Zambia in 1987 and 1988

Crop	1987 ('000 ha)	1988 ('000 ha)
Maize	609.5	723.1
Cassava	68.0	70.4
Cotton	38.2	76.1
Groundnuts	70.0	60.0
Sorghum	47.5	47.4
Sunflower	31.6	44.5
Millet	43.6	44.0
Soybeans	21.0	20.3
Pulses	23.6	17.9
Sugarcane	9.9	10.0
Rice	8.7	10.4
Wheat	7.0	7.0
Tobacco	3.5	5.0
Barley	2.5	2.5
Sweet potatoes	3.2	3.3

Source: FAO.

The production of mealy meal is an important functior in the agricultural economy.



Source: FAO.

Figure 3. Selected Crops Planted in Zambia Area Harvested, 1988.

Agricultural Practices

In Zambia there are three categories of farmers: traditional, emergent, and commercial. An estimated 85% of the farmers are classified as traditional farmers, 14% as emergent farmers, and only 1% as commercial farmers.

Traditional farmers utilize 75% of arable and permanent crop land. They have small landholdings and practice subsistence farming using only handtools and a low level of agricultural inputs. Emergent farmers typically farm less than 20 ha of land and sell 50% of their crop output. These farmers use plows, oxen, hybrid seed, fertilizers, and insecticides. Commercial farmers are those that farm more than 20 ha of land or generate an income of more than K60,000/year and typically sell over 90% of the crop yields they produce. They use mechanical farming equipment and employ modern agricultural practices.

Transport Infrastructure

The transport infrastructure related to fertilizer movement in Zambia is limited to road and railway facilities. Major urban areas are linked by all-weather roads of varied conditions. However, transportation is constrained by a shortage of vehicles and roads of poor condition. Many secondary and feeder roads are impassable during the rainy season.

The rail system links Zambia with two key import routes, i.e., Tanzania and Mozambique. However, within Zambia the system consists of a line from the north (Tunduma) to the south (Livingstone) via Lusaka and other major cities. The line also extends to the major copper-producing areas. The shortage of railwagons and locomotives is a major constraint to the movement of cargoes within Zambia and to export destinations.

Improvements in the Tanzania-Zambia railway, Tanzania-Zambia highway, and the Dar-es-Salaam port facilities are high priorities of the Southern African Development Coordination Conference (SADCC), of which Zambia is an active member.

The Fertilizer Market

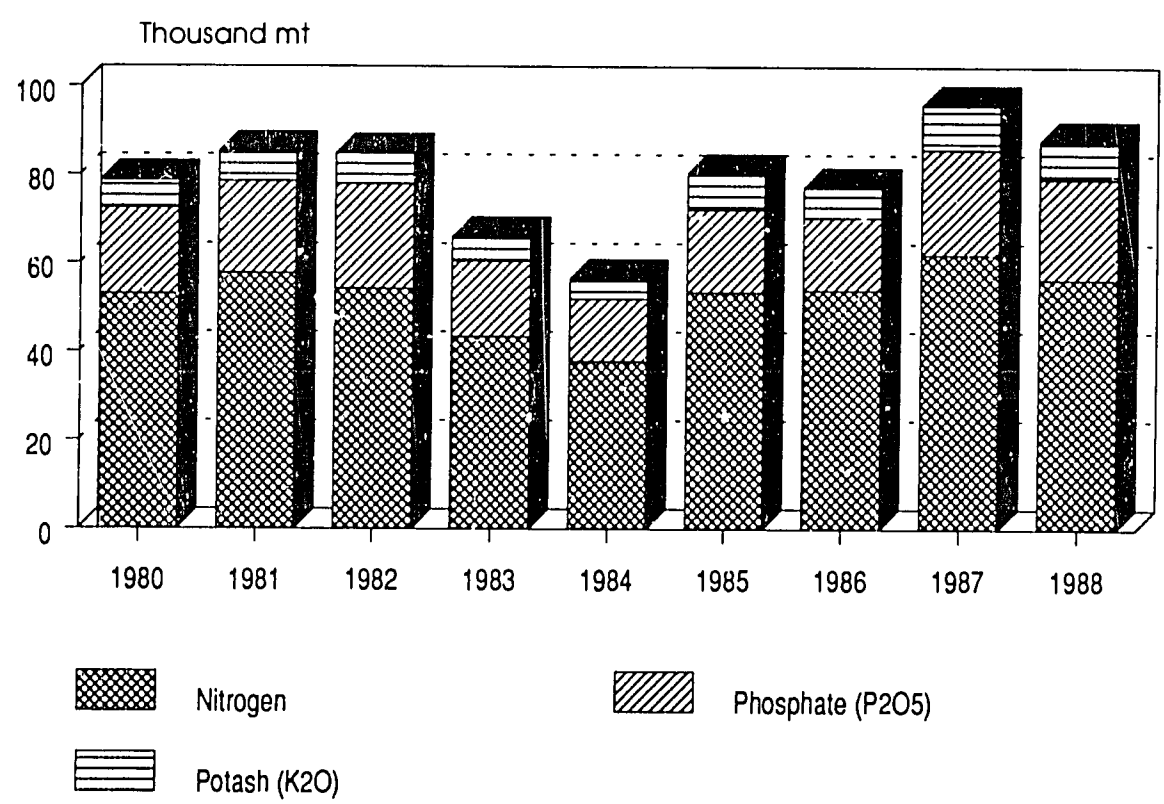
Consumption

The Zambian fertilizer market is relatively small and, largely due to supply shortfalls and unfavorable weather conditions, use fluctuated considerably during the 1980s (Table 3, Figure 4). Fertilizer use totaled 78,600 mt of nutrients in 1980 and 85,200 mt in 1981. Three consecutive years of reduced offtake, including a 22.2% decline in 1983, resulted in total fertilizer use of only 56,400 mt of nutrient in 1984. Since then, fertilizer use has rebounded, peaking at 95,800 mt of nutrient, or 243,824 mt of product, in

Table 3. Estimated Fertilizer Consumption in Zambia, 1980-88 ('000 mt)

	N	Percent Change	P_2O_5	Percent Change	K_2O	Percent Change	Total Nutrient	Total Product
1980	53.0	-	19.5	-	6.1	-	78.6	196
1981	57.6	8.7	20.9	7.2	6.7	9.8	85.2	219
1982	54.1	(6.1)	23.7	13.4	7.0	4.5	84.8	218
1983	43.3	(20.0)	17.2	(27.4)	5.4	(22.9)	66.0	166
1984	37.8	(12.7)	14.1	(18.0)	4.5	(16.7)	56.4	143
1985	53.4	41.3	18.7	32.6	8.1	80.0	80.2	211
1986	53.9	0.9	16.5	(11.8)	6.7	(17.3)	77.1	191
1987	62.0	15.0	23.9	44.8	9.9	47.8	95.8	244
1988	56.4	(9.0)	22.8	(4.6)	8.5	(14.1)	87.7	225

Source: Ministry of Agriculture.



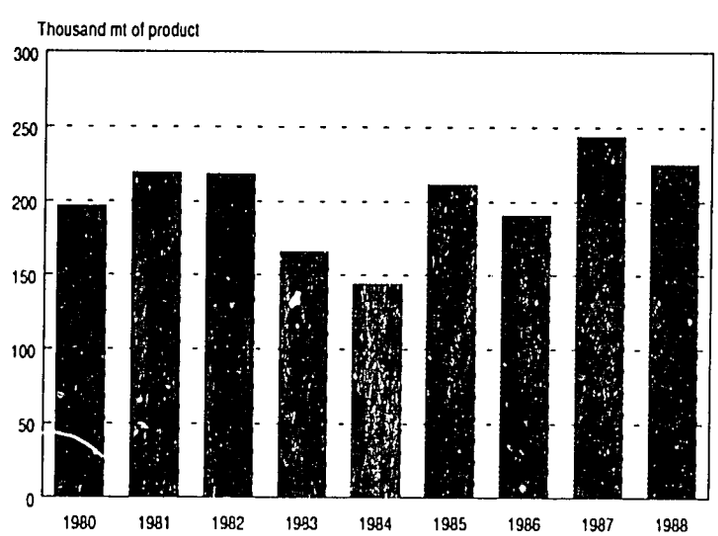
Source: National Agricultural Marketing Board, 1989.

Figure 4. Fertilizer Nutrient Use Trends in Zambia, 1980-88.

Table 4. Zambia Fertilizer Consumption by Product Type, 1980-88

Product/Year	1980	1981	1982	1983	1984	1985	1986	1987	1988
	(mt of product)								
Compound									
A (2-18-15)	58	4	18	6	6	0	34	0	0
C (6-18 12)	5,429	6,079	4,164	2,317	2,498	4,092	3,292	6,824	1 0,000
V (4-18- 15)	1,509	2,308	1,426	748	1,293	1,193	802	1,946	2,000
R (20-20 0)	38,977	41,811	31,762	17,378	18,648	22,260	13,460	22,166	25,000
X (20-10 5)	35,534	29,853	37,853	28,761	34,440	26,983	38,173	48,071	42,000
D (10-20 10)	28,921	35,923	53,366	43,396	21,689	57,518	42,388	63,751	45,000
Other (12-24-12)	0	0	0	0	724	214	47	0	0
Nitrogen									
Ammonium nitrate	24,317	26,458	21,142	16,265	11,912	9,375	6,594	17 ,820	18,000
Ammonium sulfate	1,294	1,899	2,303	261	116	972	62	0	1,000
Urea	57,171	64,793	58,764	52,627	44,425	76,335	79,389	72,192	65,000
Nitrate of soda	167	297	30	21	17	69	33	50	0
CAN	0	0	0	0	1,907	4,786	1,330	6,672	6,000
Phosphate									
SSP	517	286	99	151	131	155	374	147	1,000
TSP	2,051	1,919	622	667	336	749	1,524	565	5,000
Potash									
Potassium sulfate	78	185	64	61	167	80	7	7	100
Potassium chloride	141	105	44	110	47	64	2	14	500
Lime mixture	0	0	0	0	441	126	10	103	0
Gypsum and others	197	6,871	6,093	3,030	5,096	6,209	3,183	3,497	4 ,400
Total	**196,361**	**218,791**	**217,868**	**165,798**	**143,894**	**211,180**	**190,675**	**243,824**	**225,000**

Source: National Agricultural Marketing Board, 1989.



Source: National Agricultural Marketing Board, 1989.
Figure 5. Fertilizer Product Use Trends in Zambia, 1980-88.

1987 (Table 4, Figure 5). Delivery delays occurred again in 1988 and resulted in a decline in total use. In 1988 fertilizer consumption totaled 87,700 mt of nutrient or about 225,000 mt of product. As a result of market fluctuations, compound growth rate in fertilizer use was only 1.4% per year during the 1980s (*6*).

The intensity of fertilizer use, as indicated by fertilizer nutrient use per hectare, is low in Zambia. In 1988 Zambian farmers used about 16.2 kg of nutrient per hectare of arable land and permanent crops. That is equal to about one-fifth of the world average. In neighboring Malawi and Zimbabwe, application

rates are 21.5 and 54.2 kg/ha, respectively.

The fertilizer product mix in Zambia is characterized by the use of high-quality compound fertilizers with a high sulfur content for basal application. The grades of fertilizers used by Zambian farmers are shown in Table 5. Compounds "R", "X", and "D" account for about 90% of the market for basal fertilizers (*7*).

Urea, with consumption estimated at 65,000 mt in 1988, is by far the most popular product used for topdressing. Ammonium nitrate (AN) and, to a lesser extent, calcium ammonium nitrate (CAN) are also popular products for topdressing. The use of AN and CAN totaled 18,000 and 6,000 mt, respectively, in 1988. The consumption of ammonium sulfate in Zambia is low, primarily because Zambia's soils are very acidic (i.e., pH of 4.0 -4.5).

The use of potassium chloride and potassium sulfate as straight fertilizers in Zambia is low and, because of the predominance of NPK compounds containing potassium, this situation is not expected to change in the future.

Because of the emphasis on complex fertilizers in the product mix, the nutrient use ratio has been relatively balanced. In 1980 the N-P_2O_5-K_2O ratio was 8.7-3.2-1, and in 1988 it was 6.6-2.7-1.

The fertilizer market is divided into nine geographical zones (Table 6). The eastern, southern, and central provinces account for about 65% of total fertilizer use. The Lusaka and northern provinces account for most of the balance.

The seasonality of fertilizer use in Zambia coincides with the rainfall pattern. As indicated earlier, maize is the major crop planted and accounts for about 90% of the fertilizer used. Because planting normally occurs in late November/early December, it is estimated that 90%-95% of the fertilizer is applied during November-February. Most of the balance is applied to the winter wheat planted in mid-April-June and sugarcane (*6*).

Table 5. Grades of Compound Fertilizers Used in Zambia (*8*)

Product	N	P_2O_5	K_2O	S	B
	(%)				
Compound A	2	18	15	8-10	0.1
Compound C	6	18	12	8-10	0.1
Compound V	4	18	15	8-10	0.1
Compound R	20	20	0	10-12	0
Compound X	20	10	5	10-12	0
Compound D	10	20	10	10-12	0
Ammonium nitrate	34	-	-	-	-
Urea	46	-	-	-	-
Sulfate of ammonia	21	-	-	24	-
Triple superphosphate	-	46	-	-	-
Potassium chloride	-	-	60	-	-
Potassium sulfate	-	-	50	18	-

Table 6. Fertilizer Sales by Province in Zambia in 1986 and 1987 (*6*)

Province	1986	Percent of Total	1987	Percent of Total
	(mt of product)	(%)	(mt of product)	(%)
Eastern	55,090	27.0	50,919	20.9
Southern	37,839	18.4	48,748	20.0
Central	53,552	26.1	55,457	22.7
Northern	14,364	7.0	28,350	11.7
Copperbelt	8,420	4.0	13,926	5.7
Northwestern	2,537	1.0	4,116	1.7
Western	6,612	3.2	6,574	2.7
Lusaka	22,727	11.1	29,304	12.0
Luapula	3,849	2.0	6,422	2.6
Total	**204,990**	**100**	**243,816**	**100**

Financial Incentive to Use Fertilizer

The financial incentive to use fertilizer on maize varies by farm size and the extent of mechanization. Two measures of the farmer's financial incentives to use fertilizer are (1) the value:cost ratio (VCR) and (2) the crop:fertilizer nutrient price ratio.

During 4 of the past 7 years, the VCR for using fertilizer on maize has been in the range of 4.1-4.5 (Table 7). In 1986, the VCR was 8.4, reflecting maize prices that almost doubled while fertilizer prices remained unchanged. In 1989, the producer price of maize increased by 35% and fertilizer prices increased by about 15%, thereby resulting in a VCR of 5.2. However, in 1990, fertilizer prices increased by almost 365% while the producer price of maize increased by only 160%. As a result, the VCR for fertilizer use on maize declined to 2.95 (*8*).

The crop:fertilizer nutrient price ratio has been relatively favorable during the 1984-90 period. Generally 3-4 kg of maize is required to buy 1 kg of nutrient. Following the major increase in fertilizer prices in 1990, however, the crop:fertilizer nutrient price ratio increased to 5.74 (Table 8).

Table 7. Value:Cost Ratios for Hybrid Maize, 1984-90 (*6*)

	Marginal Output[a]	Maize Price/kg[b]	Value of Marginal Output	Fertilizer Price/ 50 kg Bag[c]	Marginal Cost/kg Nutrients	Value: Cost Ratio
	(kg)	(Kwacha)				
1984	17	0.272	4.6	24.10	1.12	4.1
1985	17	0.315	5.4	26.75	1.24	4.4
1986	17	0.611	10.4	26.75	1.24	8.4
1987	17	0.867	14.7	72.50	3.37	4.4
1988	17	0.889	15.1	72.50	3.37	4.5
1989	17	1.200	20.4	84.64	3.94	5.2
1990	17	3.155	53.6	390.00	18.14	2.9

a. Based upon estimates by J. K. McPhillips.
b. Price of grade A maize based on 90-kg bag prices.
c. Urea and compound D (10-20-10) used in calculation. Price for each was K24.10 per 50-kg bag through 1986. An average price was used for years 1987-90.

Table 8. Crop:Fertilizer Nutrient Price Ratio, 1984-90 (*6*)

Year	Cost Per kg of Nutrient	Producer Price Per kg of Maize	Crop:Fertilizer Nutrient Price Ratio
	(Kwacha)	(Kwacha)	
1984	1.12	0.272	4.12
1985	1.24	0.315	3.94
1986	1.24	0.611	2.02
1987	3.37	0.867	3.89
1988	3.37	0.889	3.79
1989	3.94	1.200	3.28
1990	18.14	3.155	5.74

The retailer is a key link in the marketing chain.

Fertilizer Marketing System

Government Involvement

For the past 20 years, fertilizer marketing in Zambia has been carried out by the Government. Either through direct decisions by a Government body or through operation of parastatals, the Government has administered or performed essentially all fertilizer marketing functions.

The National Agricultural Marketing Board (NAMBOARD), a parastatal organization under the Ministry of Agriculture, was created in the late 1960s to deal with the marketing of agricultural inputs and the procurement of major crops. It maintained its monopolistic status throughout the 1970s. However, in 1980 the Government changed its strategy on agricultural sector development to include a more decentralized approach to agricultural input and output marketing. This involved (1) development of a cooperative system, (2) creation of produce marketing boards to deal with the marketing of certain cash crops, and (3) transfer of NAMBOARD's responsibilities as a marketer of improved seeds to Zambia Seed Corporation (ZAMSEED), another parastatal organization. As a result of these actions, the range of NAMBOARD's operations was significantly reduced. With respect to fertilizer marketing, NAMBOARD retained its status as the central fertilizer procurement organization and arranged distribution to 21 major depots located throughout the country.

The responsibility for downstream retail fertilizer marketing was given to the cooperative system through the Provincial Cooperative Marketing Unions (PCMUs). The PCMUs are autonomous parastatal organizations. As autonomous entities, they receive some degree of support from the Zambia Cooperative Federation (ZCF), a central parastatal agency; however, their individual operation remains independent. In order to carry out their marketing functions, the PCMUs assumed control of NAMBOARD's extensive retail network (*6*).

During the 1980s, NAMBOARD's role as a fertilizer marketer continued to decline. The PCMUs were given increased responsibility in terms of expansion of the marketing channel system to the extent that, by the late 1980s, NAMBOARD controlled only four fertilizer supply points; the PCMUs were firmly positioned as the principal fertilizer marketer in Zambia. NAMBOARD's duties as a fertilizer marketer consisted of forecasting national fertilizer demand, procurement of supplies (via the Tender and Supply Board), physical distribution to its four warehouses, and sales to PCMUs and farmers from its warehouses (*6*).

During the late 1980s, the Government's policy and development strategy began to shift toward increasing the role of the private sector. In the fertilizer sector, this meant that the responsible Government agencies would need to improve efficiency of operation, and avenues for private-sector participation would be created where possible. The first action was to increase the level of expertise in terms of fertilizer business planning, procurement of supplies, and physical distribution to strategic points in the country. This led to the final dissolution of NAMBOARD in mid-1989 and the transfer of its fertilizer marketing responsibilities to Nitrogen Chemicals of Zambia Ltd. (NCZ), a parastatal organized under the Zambia Industrial and Mining Corporation Ltd. (ZIMCO) and the sole fertilizer producer in Zambia. Although NCZ does make direct sales to farmers from its central warehouse, the PCMUs, through a network of district cooperative unions (DCUs) and rural depots, are responsible for most of the retail fertilizer sales (Figure 6).

Although the Government has publicized its intentions of moving toward liberalization of the market, parastatals continue to control the marketing system. In addition, the Government, through the Ministry of Agriculture, continues to administer uniform fertilizer prices.

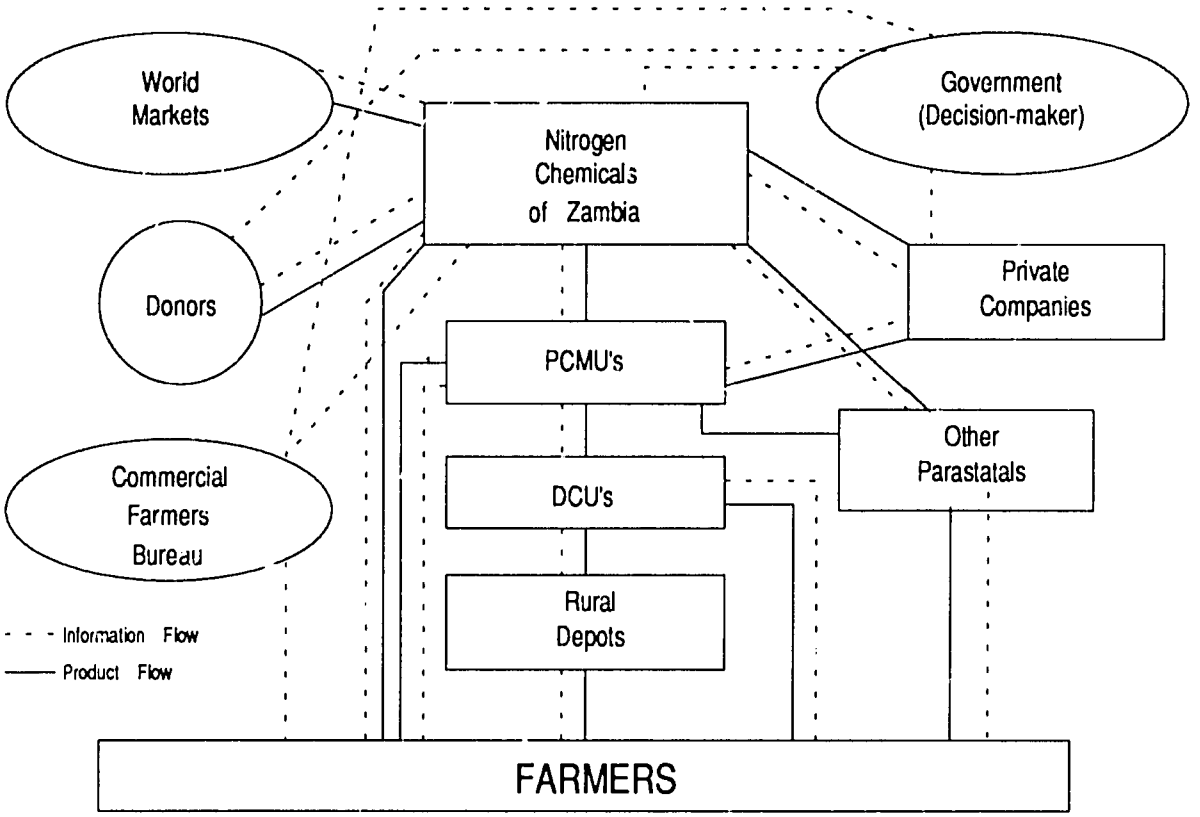


Figure 6. Fertilizer Marketing in Zambia.

Fertilizer Supply

Zambia derives its fertilizer supplies from three sources: local production by NCZ, commercial imports, and donors. The contribution of each of these sources to Zambia's total fertilizer supply varies from year to year, primarily depending upon the availability of foreign exchange to import fertilizers and fertilizer availability from donors.

NCZ is the only fertilizer manufacturer in Zambia. Its production facilities are located in Kafue, approximately 30 miles south of Lusaka. A description of the NCZ facilities including the production processes, the plant contractor, design capacity, actual capacity, year of commissioning, and year of rehabilitation is shown in Table 9. Because of various operating problems, including equipment failure, power interruptions, and raw material shortages, NCZ's plant-operating efficiency is typically around 40%-50% of design capacity or about 50,000-80,000 mtpy of product (Table 10). Production levels are expected to reach only about 25% of design capacity in 1990 because of unexpected delays in the plant rehabilitation program now in progress. Once refurbishing is completed, plant operating efficiency should be about 80% of design, assuming power supply interruptions and raw material shortages are minimized. Completion of the plant rehabilitation program is rescheduled for late 1991.

Raw materials for fertilizer production include coal from the Maamba Mines and local pyrites. In addition, imports of such fertilizers as urea, triple superphosphate (TSP), potassium chloride, and potassium sulfate are needed for compound fertilizer production.

The availability of fertilizers from donors is typically subject to a high degree of uncertainty for developing countries. This is particularly true in Zambia where, as indicated in Table 11, donor supplies have fluctuated dramatically during the past decade. Donors supplied only 16,000 mt of fertilizer, or 11% of total imports, in 1981

Table 9. NCZ Fertilizer Plant Profile

Production	Process	Contractor	Design Capacity	Actual Capacity	Commissioning Year	Rehabilitation Year
Coal gasification	Krupp-Koppers	Kobe steel (Line O) NCZ Line A	320 mtpd of coal	306 mtpd	1970	1986
Coal gasification expansion	Krupp-Koppers	Klockner (Line B,C)	320 mtpd of coal		1981	-
Ammonia plant	UBE-Japan H2S removal: Stadford process	Kobe steel	95 mtpd	84 mtpd	1970	1986
Ammonia plant expansion	Casale (NH3) Krupp-Koppers (CO conversion) (Rectisol methanol)	Klockner	217 mtpd	128 mtpd	1981	1988
Nitric acid	Montecatini	Kobe steel	172 mtpd	172 mtpd	1970	1986
Nitric acid exp.	Grande paroisse	Klockner	212 mtpd	195 mtpd	1981	1988
Ammonium nitrate	Sumitomo	Kobe steel	226 mtpd	205 mtpd	1970	1986
Ammonium nitrate expansion	Kestener	Klockner	242 mtpd	242 mtpd	1981	1988
Ammonium sulfate	Kestener	Klockner	151 mtpd	151 mtpd	1981	1988
NPK plant	Cdf Chemie	Klockner	142,000 mtpy	100,000 mtpy	1981	1988
Sulfuric acid plant	Nissan Chemicals (Shanki, Japan for roasting section)	Kobe steel	60,000 mtpy	22,000 mtpy	1983	-

Source: Nitrogen Chemicals of Zambia Ltd.

Table 10. Fertilizer Production in Zambia, 1980-90

Product/Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	(mt of product)										
Compound											
C	-	-	-	2,750	-	-	-	-	-	-	6,000
V	-	-	-	-	-	-	-	-	-	-	1,500
R	-	3,591	12,110	9,610	18,637	9,592	4,689	22,485	-	-	-
X	-	2,056	-	40,146	49,582	3,807	24,071	32,099	34,408	10,000	9,500
D	-	-	21,762	-	-	-	20,775	3,247	42,266	59,760	28,000
Ammonium nitrate	18,882	14,154	25,637	17,621	8,580	6,481	7,739	10 ,559	3,689	-	-
TOTAL	**18,882**	**19,801**	**59,509**	**70,127**	**76,799**	**19,880**	**57,274**	**68,390**	**80,363**	**69,760**	**45,000**

Source: Nitrogen Chemicals of Zambia Ltd.

versus 143,340 mt of fertilizers or 80% of total imports in 1988. It is expected that donors will account for about 23% of Zambia's fertilizer imports in 1990. Because of the scarcity of foreign exchange for fertilizer procurement, aid imports are critical to Zambia. However, the lack of forward planning by donors and their failure to make long-term commitments in terms of the types, quantities, and timing of deliveries jeopardize fertilizer supply in the country in that commercial import requirements are finalized only after donor intentions are established.

Because of the rehabilitation efforts at the NCZ plant and a reduction in donor supplies during the past 2 years, most of

Table 11. Donor Aid and Commercial Imports of Fertilizer[a], 1980-90 (6)

Product/Year	1980	1981	1982	1983	1984	1985[b]	1986	1987	1988	1989	1990[c]
	(mt of product)										
Commercial Imports											
Compound											
"C"	5,000	6,000	-	3,000	-	-	-	6,000	-	7,300	-
"V"	-	-	-	3,000	-	-	-		-	3,200	-
"R"	-	30,000	20,000	-	-	-	12,000		-	37,800	21,500
"X"	-	29,000	-	-	-	-	-		-	42,100	34,000
"D"	20,751	45,000	0	40,000	73,000	-	24,000	32,000	1,000	48,100	18,500
Urea	54,000	15,000	60,000	75,000	53,297	-	15,000	8,500	35,500	57,592	38,000
Ammonium nitrate	-	-	-	-	-	-	5,000	13,000	-	36,800	16,100
Subtotal	**79,751**	**125,000**	**80,000**	**121,000**	**126,297**	**-**	**56,000**	**59,500**	**36,500**	**232,892**	**128,100**
Donor Aid Imports											
Compound											
"C"	-	-	-	-	-	-	4,000	3,000	9,000	-	-
"V"	-	-	-	-	-	-	2,000		2,200	-	-
"R"	43,244	-	20,000	-	-	-	-		28,080	9,000	-
"X"	34,875	16,000	-	-	-	-	24,000	15,000	15,340	-	10,000
"D"	-	-	-	-	1,480	-	10,000	200	13,400	14,300	-
Urea	12,908	-	10,000	11,300	42,381	30,456	47,613	28,700	32,820	19,250	18,000
Ammonium nitrate and CAN	-	-	-	-	25,000	-	-	28,800	42,500	-	10,000
Subtotal	**91,027**	**16,000**	**30,000**	**11,300**	**68,361**	**30,456**	**8[illegible],613**	**105,700**	**143,340**	**42,550**	**38,000**
TOTAL	**170,778**	**141,000**	**110,000**	**12[illegible],300**	**195,158**	**30,456**	**143,613**	**165,200**	**178,840**	**275,442**	**166,100**

a. Excluding raw materials for NCZ plant.
b. Data incomplete.
c. Contracts signed for indicated quantities.

Zambia's fertilizer supplies have been procured on the international market on a commercial basis. Commercial imports totaled 232,892 mt and 128,100 mt of product in 1989 and 1990, respectively. The main products imported by quantity are presented in Table 11. As previously indicated, subject to foreign exchange availability, commercial imports bridge the gap between fertilizer requirements and supply availability from domestic production, donors, and in-country carryover stocks.

Procurement

NCZ is responsible for all activities related to the procurement of fertilizers on the international market, including determination of the types and quantities of fertilizers to import. Having assumed this function in the takeover from the now defunct NAMBOARD, NCZ has moved away from the previous system of using the Tender and Supply Board to procure fertilizer. The procurement method is based upon an open tender. NCZ prepares the tender document, opens the bids, evaluates offers, makes the awards, and contracts directly with suppliers. The total process, from determining import targets to finalizing the contracts, typically takes about 4 months. Once contracts are finalized, NCZ works with the Ministry of Finance and local financial institutions to establish letters of credit in favor of the suppliers.

Physical Distribution

The physical flow of fertilizers through the distribution system in Zambia is depicted in Figure 6. The major channel members involved are NCZ and the cooperative unions. A small number of private companies and other parastatals also perform the fertilizer transport and storage function; however, the volume of fertilizers handled by these channel members is very low.

As indicated previously, the supply of fertilizers originates both outside Zambia and within the country. Because Zambia is landlocked, imports present a major challenge to the sole importer, NCZ. In addition to the problems

with delivery scheduling in an environment where railway capacity is limited, the cost of imported fertilizers is very high, and physical losses between the time of arrival in the port and forward delivery to Lusaka are estimated at 5%-10%.

Fertilizers imported into Zambia originate from either the factories in Harare, Zimbabwe, and Johannesburg, South Africa, or through one of the four main ports that serve Zambia:

1. Beira, Mozambique.
2. Nacala, Mozambique.
3. Dar-es-Salaam, Tanzania.
4. Durban, South Africa.

Dar-es-Salaam is by far the predominant port used, accounting for 70%-80% of Zambia's fertilizer imports. The Mozambique ports have also been used in the past. During recent years, because of civil unrest and scarcity of rail wagons to transport cargo to Zambia, only the Beira route has been utilized. The import route through Durban, South Africa, is available but used infrequently due to the higher cost relative to the other routes.

All four ports used for importing fertilizers, as well as the plant locations in South Africa and Zimbabwe, are linked to Lusaka by railways (Figure 7). For all routes, a shortage of rail wagons and locomotives delays shipment of fertilizers to Zambia. Although not a major problem for deliveries from South Africa, in-transit time for fertilizers shipped via Tanzania or Mozambique often

exceeds 3 months. Because of long in-transit periods, including frequent temporary open-air storage and limited availability of tarpaulins, losses are excessive. Further, the portion of fertilizers that are damaged in transit to Lusaka is very high.

Contracts for all imported fertilizers are based on cost, insurance, and freight (c.i.f.) Lusaka. In order to minimize double handling and pressure on the transport system and to reduce distribution costs, NCZ prepares a detailed logistics plan to allow off-loading

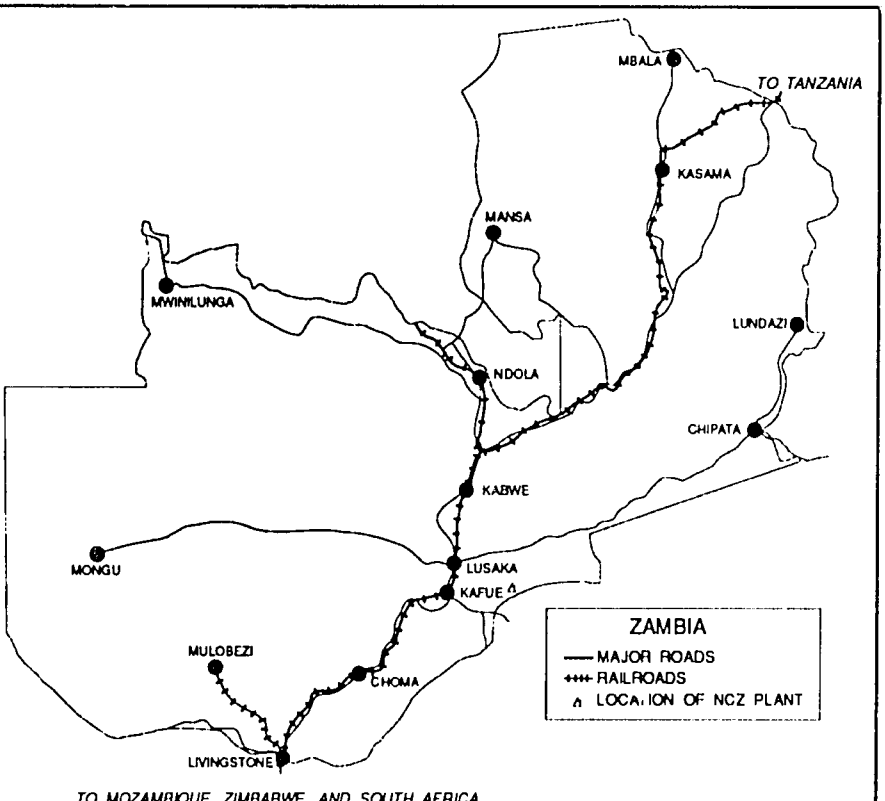


Figure 7. A Map of Zambia Indicating Major Routes and Location of the Nitrogen Chemicals of Zambia Plant at Kafue.

Table 12. Fertilizer Storage Capacities in Existing Sheds and CIDA Sheds, 1987

Province	Depot	Existing Sheds	CIDA Sheds	Total Sheds
		---------- (mt of product) ----------		
Southern	Livingstone	3,500	-	3,500
	Choma	-	17,500	17,500
	Monze	6,500	14,000	20,500
	Kaleya	-	8,750	8,750
	Mazabuka	-	7,000	7,000
	TOTAL	**10,000**	**47,250**	**57,250**
Lusaka	Fert. Branch	60,000	-	60,000
Central	Chisamba	5,000	-	5,000
	Natuseko	3,500	7,000	10,500
	K/Mposhi	3,000	-	3,000
	Mumbwa	3,500	3,500	7,000
	Mkushi	-	17,500	17,500
	Subtotal	**15,000**	**28,000**	**43,000**
Copperbelt	Ndola	18,000	-	18,000
	Kitwe	2,500	-	2,500
	TOTAL	**20,500**	**-**	**20,500**
Eastern	Chipata	4,500	7,000	11,500
	Katete	-	7,000	7,000
	Lundazi	-	7,000	7,000
	Petauke	-	3,500	3,500
	TOTAL	**4,500**	**24,500**	**29,000**
Northern	Kasama	800	3,500	4,300
	Mpika	-	3,500	3,500
	Mbala	-	3,500	3,500
	Mwenzo (Isoka)	-	3,500	3,500
	Subtotal	**800**	**14,000**	**14,800**
Western	Kaoma	3,500	-	3,500
	Mongu	1,000	-	1,000
	Subtotal	**4,500**	**-**	**4,500**
Luapula	Mansa	500	3,500	4,000
Northwestern	Solwezi	700	3,500	4,200
GRAND TOTAL		**116,500**	**120,750**	**237,250**

Source: National Agricultural Marketing Board.

at designated points en route to Lusaka.

Railways link most of the key fertilizer market areas in Zambia (Figure 7). A major exception is the eastern province where, as in the western and northwestern provinces, fertilizer movement is by truck. Fertilizer transport to the district and rural depots is also by truck.

Temporary storage of fertilizers is essential to ensure that supplies are available when needed. As indicated in Table 12, Zambia has facilities with a capacity to inventory up to 237,250 mt of fertilizers, or about 1 year's sales by NCZ. About one-half of the facilities are classified as

existing sheds of varied quality; the others are warehouses constructed under the Canadian International Development Agency (CIDA) program. At the present time, NCZ maintains only the 60,000-mt warehouse in Lusaka and its plant-site storage facility. The remaining storage capacity is operated by the cooperative unions. In addition to the use of storage sheds, temporary open storage is used in many rural depots. The fertilizers are stacked on dunnage and covered by tarpaulins when available.

Fertilizer moving from retailer to farm by wagon.

Pricing

The main characteristics of fertilizer prices in Zambia are as follows: (1) prices are controlled by the Government, (2) the pricing system is based upon a uniform price policy, and (3) until 1990 a subsidy rate of about 50% was maintained.

In the past, the methodology used in establishing prices involved a number of factors including the following:

1. The quantities of fertilizer to be supplied by NCZ, donors, and via commercial imports are determined.
2. The average cost per ton of imported and locally produced fertilizers is calculated.
3. The Ministry of Finance indicates how much is available for fertilizer subsidies.
4. The Ministry of Agriculture calculates the selling price of fertilizer on the basis of what is available for subsidy.

Although the exact formula used for setting fertilizer prices is not known, the main considerations appeared to be in keeping prices to farmers as low as possible, subject to national budget limitations. The pricing mechanism did not offer any financial incentive for market development, nor did it encourage efficiency in the fertilizer marketing system.

One consequence of the absence of a formal pricing formula has been that prices have been adjusted fairly erratically, as indicated in Table 13. After 3 years of being relatively static, prices of all fertilizer

Table 13. Fertilizer Prices in Zambia, 1983/84-1988/39 (*6*)

Fertilizer Product	1984	1985	1986	1987	1988	1989	Estimated 1990
	(Kwacha/50 kg bag)						
"R"	24.10	26.75	26.75	80.00	80.00	92.00	336.00
"X"	24.10	26.75	26.75	80.00	80.00	94.83	383.00
"D"	24.10	26.75	26.75	80.00	80.00	98.27	396.00
Ammonium nitrate	23.20	25.85	26.85	56.00	56.00	64.00	383.00
Ammonium sulfate	22.55	25.20	25.20	48.00	48.00	53.00	
Urea	24.10	26.75	26.75	65.00	65.00	71.00	384.00
SSP	22.50	25.15	25.15	50.00	50.00	71.50	293.00
TSP	25.80	28.45	28.45	64.00	64.00	77.00	346.00
Potassium chloride	21.10	23.75	23.75	55.00	55.00	69.50	389.00
Potassium sulfate	20.85	23.50	23.50	80.00	80.00	102.00	

products increased sharply in 1987, with the price of compounds up by 300% over the 1986 level. The reasons for this sudden increase were apparently tied to the devaluation of the Kwacha and the general increase in international fertilizer prices. The prices set for 1987 remained in effect for 1988, and 1989 prices were increased by an average of 20%.

Because fertilizer prices were fixed at a uniform level, the Government provided an allowance to partially offset the distribution costs incurred by NAMBOARD and the cooperative unions. The allowances were K400 and K200 for NAMBOARD and the cooperative unions, respectively. Regardless of the efficiency level in minimizing costs and physical losses, the marketing channel members received the established allowance. Both allowances were provided as a direct subsidy to the two organizations and were not reflected in the price of fertilizer.

The Government has recently attempted to eliminate the subsidy on fertilizers. On the basis of estimated product and marketing costs, the Government has increased prices to a level that approximates the estimated total cost involved in moving fertilizer to the retail level and provides a reasonable margin for NCZ and the cooperative unions. As a result of this action, retail prices, which continue to be fixed on a countrywide basis, have increased by an average of over 300% during the past year (*6*).

Cost of Marketing

Fertilizer marketing costs include all costs incurred in the process of channeling fertilizer from the point of production to the retail point of sale. NCZ typically purchases fertilizers on a c.i.f. Lusaka basis, whereby the seller is responsible for arranging for port clearance and forward delivery to Lusaka. As indicated in Table 14, domestic marketing costs are estimated at K6,520/mt or about 40% of the total cost, exclusive of profit margins. The major marketing costs are for (1) interest on working capital (K2,800/mt) and (2) transport (K1,510/mt).

The physical product losses in the marketing system are substantial; they constitute a major cost item and one of the major inefficiencies in the current fertilizer marketing system. Under NAMBOARD, losses were estimated at 3% or K460/mt. The loss figure for the cooperative union is 5% or K670/mt (*6*).

As mentioned earlier, being landlocked places a major burden on the fertilizer marketing system in terms of the high costs of transport and the long time periods that working capital is committed to fertilizer stocks. In addition, physical losses are unusually high in Zambia. In addition to inefficient management, high losses are directly linked to long transport distances, the absence of suitable temporary storage in the port areas, and excessive handling during delivery to the retail point of sale.

Credit

Whether in cash or in kind, agricultural credit is essential for developing and sustaining a strong agricultural economy. Credit is a strong factor in encouraging small farmers to adopt new technologies for higher yields and a powerful incentive to increase production and income.

Below: Credit programs provide farmers with purchasing power for essential crop production inputs.

Table 14. Estimated Cost of Marketing Fertilizer in Zambia, 1991 Season (6)

Item		Amount (K/mt)	
c.i.f. Lusaka (urea)			9,880.00
NCZ costs			
Handling and transport	40.00		
Salaries and wages	50.00		
Insurance	45.00		
Rebagging	5.00		
Bank charges (12 months)	2,800.00		
Other costs (including losses)	640.00		
Subtotal NCZ Marketing Cost and Margin		3,580.00	
Cooperative unions cost			
Transport	1,510.00		
Salaries and wages	160.00		
Other costs (including losses)	1,270.00		
Subtotal Cooperative Unions Marketing Costs		2,940.00	
TOTAL MARKETING COST			**6,520.00**
TOTAL COST OF UREA AT RETAIL OUTLET (excluding profit margin)			**16,400.00**

Note:
1. Exchange rate: K40 = US $1.00.
2. NCZ handling/transport costs are minimal because imports are received c.i.f. NCZ warehouse Lusaka basis. Transport costs would apply to product produced at Kafue.

The agricultural credit system in Zambia has three major segments: the farmer (borrower), the policymaker, and the institutional structure. The institutional structure includes lenders from both the private and Government sectors.

The primary private-sector lenders are the commercial banks (Barclays, Standard, and Zambia National Commercial Bank), which provide loans primarily for the commercial farmers. Loans to commercial farmers involve a seasonal line of credit or overdraft financing. Barclays and Zambia National Commercial Bank also have special loan programs for small farmers.

The Government-sponsored lenders include ZCF, the Lima Bank, CUSA Zambia Limited, Lint Company Limited (LINTCO), and the National Tobacco Company Limited (NATCO).

ZCF, which derives most of its funds from donors, is heavily involved in downstream fertilizer marketing, including the provision of credit to qualified farmers. Credit is channeled through ZCF Finance Services which is a ZCF subsidiary. This body was created by the nine Provincial Credit Unions. The Unions own 45% of the shares, and ZCF owns 55%. The primary lending activity, representing about 80% of their total loans, involves seasonal loans to farmers. The remaining 20% goes for intermediate financing.

Credit to the Provincial Credit Unions is through a Cooperative Credit Scheme (CCS). The CCS program involves block loans to local unions. The unions lend the funds to societies who, in turn, lend the funds to individual society members. Most funds are disbursed to small-scale farmers having farms that average about 2.5 ha. Loans are made in kind rather than cash.

Recovery rates are high, averaging 89% for the past 3 years.

ZCF Finance Services does not meet the full fertilizer credit demand of the Provincial Credit Union members, which in 1990 was estimated at K200 million. The institution was able to supply only about 50% (about K92 million) of demand. Credit is also not always provided at the right time for farmers to maximize its use. The time required from application to clearance of a loan is a minimum of 4 months.

The Lima Bank was registered as a commercial bank and started operations on June 1, 1987. The major objective, as stated by the Government in setting up the Lima Bank, was to rationalize and strengthen agricultural credit in Zambia. The Government also has plans to make it the principal agricultural lending institution and official channel for Government and international assistance to the agricultural and fisheries sectors. Shareholding in the bank is open to all interested investors, both residents and nonresidents.

The Lima Bank disburses short- and medium-term loans directly to all farmers. The funds allocated to the Lima Bank for each province are divided among farm applicants for loans on the following basis:

1. Small-scale farmers (1-10 ha) receive an average 85% of the total allocation of funds.
2. Medium-scale farmers (10-40 ha) receive an average 13% of the total allocation of funds.
3. Large-scale farmers (40 ha and above) receive an average 2% of the total allocation of funds.

In both 1987 and 1988, the Lima Bank received over 77,000 applications for agricultural loans. Funds requested totaled K81 million in 1987 and K600 million in 1988. About 50% of the loans were approved, and the total amount of loans in 1987 and 1988 was K19 million and K260 million, respectively. The majority of applications received and approved were from small-scale farmers, and an estimated 20% were for fertilizer.

The Credit Union and Credit Cooperative Society plays an important role in meeting the demand for short-term and seasonal agricultural credit. The cooperative credit program, established under the Cooperative Societies Act on March 1, 1972, has the following objectives:

1. To promote savings among its members and develop a source of credit for them at controlled rates of interest exclusively for production purposes.
2. To establish multipurpose cooperative societies as the media for the administration of agricultural credit, using funds borrowed, in the first instance, wholly or in part from Government lending institutions with the possibility of gradual replenishment of such loan funds by a policy of "forced savings" on the part of borrowers.

Loans under this system comprise short- (seasonal) and medium/long-term (3-5 years) loans to small- and medium-scale farmers primarily for housing, grinding mills, and oxen. It is estimated that only about 15% of the loans are used to purchase fertilizer, and this is mainly by medium-scale farmers. The credit recovery rate has averaged about 90% over the past 5-year period. The institution estimates that it is meeting only about 50% of the annual credit demand.

LINTCO was formed in 1987 to take over from NAMBOARD all functions related to seed cotton production and marketing. Recently, the company was also given the responsibility for promoting soybean and coffee production among small-scale farmers. The objectives of the company are to:

1. Increase cotton, soybean, and coffee production in the country.
2. Provide inputs and credit to cotton, soybean, and coffee producers.
3. Provide a market for cotton growers.
4. Provide extension services to cotton, soybean, and coffee growers.

LINTCO is a parastatal company limited by shares and registered according to the Zambia Companies Act. The Ministry of Finance holds 99% of the shares with 1% being held by the General Manager. The company's Board of Directors is appointed by the Government.

Funds for credit to farmers are obtained as bank overdrafts from Barclays Bank (Zambia) limited in the amounts of K40-50 million

overdraft. Credit to farmers is in the form of seasonal and in-kind loans mainly for seed planting costs, chemicals, and spraying. Fertilizer has not, to date, been part of LINTCO's credit package; farmers have been encouraged to produce cotton and soybeans in rotation with maize, thereby benefiting from the residual effects of fertilizer used on maize. The institution has, however, recently begun a pilot program in providing interest-free fertilizer loans to a few farmers in the eastern province. The company provides fertilizer loans for coffee growers and also for a number of soybean growers. Overall, fertilizer loans account for only 10% of LINTCO's total lendings. The LINTCO credit recovery rate is about 80%.

NATCO was formed in 1988 to take over from The Tobacco Board of Zambia all functions related to tobacco production. Wholly owned by the Government, the company has the following objectives:

1. Increase tobacco production.
2. Provide inputs and credit to tobacco producers.
3. Provide extension services to tobacco producers.

NATCO has attracted small-scale farmers and, to some extent, emergent farmers into tobacco production by providing seasonal credit in the form of inputs at low interest rates. Disbursements of input credit are in the form of seedlings, fertilizers, tractor hire, chemicals, packing materials, etc. The current rate of loan recovery is about 80%. Tobacco is an important cash crop for Zambia farmers.

Tobacco production is also profitable to farmers.

Fertilizer Recommendations

Most farmers in Zambia are aware of the value of using fertilizers. Timely availability and purchasing power at the farmer level are larger constraints to fertilizer use than is awareness of benefits. Crops that receive first priority for fertilizer use are maize, tobacco, wheat, vegetables, and selected speciality crops, e.g., sunflower, etc. (*6*).

Virtually all of the fertilizer used by small-scale farmers is applied to maize. Although maize production is dependent on climatic conditions, crop and fertilizer prices, and several other factors, it is interesting to note that variations in maize yield and fertilizer consumption correspond closely. Figure 8 shows

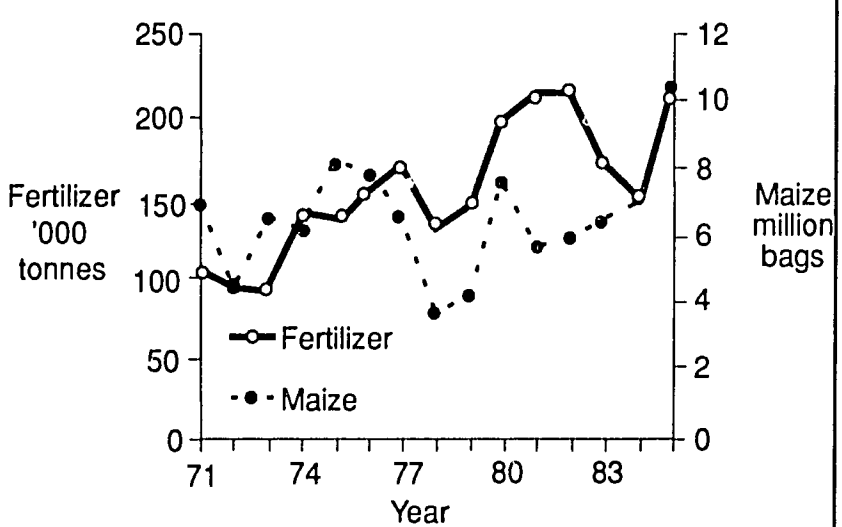


Figure 8. Maize Production and Fertilizer Use (*8*)

fertilizer consumption in metric tons of product used and maize yields in 90-kg bags for the period 1971-85. In 1985/86, more than 10 million bags of maize was produced. In that same period, 211,000 mt of fertilizer product was consumed. In 1978, by comparison, 130,000 mt of product was used and the maize yield was approximately 50,000 bags. Only in the 1975/76 and 1985/86 crop seasons has marketed maize exceeded 8 million bags in Zambia. Maize production in the 1983 and 1984 season was less than 7 million bags, primarily because of a drought and not necessarily because of a shortage of fertilizer (*8*). It is important that Zambia have an adequate supply of appropriate fertilizer available for its farmers.

Fertilizer recommendations for crop production in Zambia have a sound foundation. The research trials were full-scale replicated factorials carried out for a minimum period of 3 years. Trials were carried out in all provinces on research stations and also on farmers' fields. Current major constraints to crop production in Zambia are N, P, K, and S deficiencies, soil acidity and the associated Ca and Mg deficiency, and Al toxicity (*11*)

The fertilizers that are normally available in Zambia are shown in Table 5 by nutrient analysis. The compounds have been especially formulated to meet the soil, crop, and climatic conditions in Zambia. Six different compounds are recommended in Zambia, and all contain a minimum of 8% sulfur (S). The mixtures "A" (2-18-15), "V" (4-18-15), and "C" (6-18-12) also contain 0.1% boron (B). These mixtures are intended primarily for cotton; however, they may be used for other boron-responsive crops and especially those grown on low-pH soils where the boron has leached out or on soils low in organic matter.

Fertilizer recommendations by crop for Zambia are shown in Table 15. The recommendations provide a general guideline for fertilization and are oriented for improved management and top commercial farmers. The difference between recommendations for crops grown under improved management and those grown by commercial farmers is significant. For example, on maize the recommendation for improved management is 200 kg of compound "X" (20-10-5) and 200 kg of AN for a total rate of 107 kg of N, 20 kg of P_2O_5, and 10 kg of K_2O/ha. This can be compared with the recommendation for the top commercial farmer of 300 kg of compound D (10-20-10) and 300 kg of urea for a total nutrient application of 168 kg of N, 60 kg of P_2O_5, and 30 kg of K_2O/ha.

Recommendations for commercial crop producers published by the Ministry of Agriculture are shown in two different ways. The recommendations for top commercial producers, as shown in Table 15, are average recommendations given in kilogram of fertilizer products per hectare. Recommendations for commercial crop producers are also given in more detail based on low, medium, and high levels of management. The Ministry of Agriculture recommendations, as shown in Table 16, are given in kilogram of nutrients per hectare (*9*).

Agricultural research, seeking out means for the farmer to improve yields at

Table 15. Fertilizer Recommendations for Principal Crops Grown in Zambia (*8*)

Crop	Improved Management (kg/ha)	Top Commercial (kg/ha)
Maize	200 "X" + 200 AN	300 "D" + 300 urea
Cotton	200 "X" + 200 AN	300 "D" + 100 urea
Tobacco (flue cured)	300 "C"	600 "C"
Burley	200 "C" + 200 AN	400 "C" + 300 AN
Beans (dried)	200 "X"	300 "D" + 150 AN
Soybeans	200 "D" + Inoculum	300 "D" + Inoculum
Rice	200 "D"	300 "D" + 100 SA
Sunflower	200 "D"	300 "D" + 100 AN
Groundnuts	Recommended to be grown after a fertilized crop	200 single superphosphate or mixture "D"

a reduced cost per unit, is a never-ending endeavor. For the past few years, Zambia has relaxed its fertilizer research. In a country with an agriculturally based economy, it is important that agricultural research be current. Fertilizer recommendations must be continuously updated to meet changing agricultural conditions.

A termite mound—agricultural research on constraints to crop production is a never-ending endeavor.

Table 16. Commercial Crop Production Recommendations of Selected Crops (9)

Crop	Fertility Status	N	P_2O_5	K_2O	S[a]
		(kg/ha)			
Maize	(1) Low	160-180	70-100	30-40	20
	(2) Medium	120-140	40-60	10-20	20
	(3) High	80-100	20-30	0	15
Wheat[b]	(1) Low	140-160	80-120	40-60	20
	(2) Medium	110-130	50-70	20-30	20
	(3) High	80-100	20-40	0	15
Sorghum	(1) Low	70-90	50-60	30-40	20
	(2) Medium	40-60	30-40	10-20	20
	(3) High	0-30	0-20	0	15
Rice	(1) Low	70-90	100-120	30-40	15
	(2) Medium	50-60	70-90	10-20	15
	(3) High	30-40	40-60	0	10
Soybean	(1) Low	20-30	60-80	40-60	20
	(2) Medium	10-15	30-50	20-30	20
	(3) High	0	0-20	0	15
Sunflower	(1) Low	70-90	50-60	30-40	20
	(2) Medium	40-60	30-40	10-20	20
	(3) High	0-30	20-30	0	15
Cotton[c]	(1) Low	70-80	70-90	30-40	20
	(2) Medium	40-60	40-60	10-20	20
	(3) High	20-30	20-30	0	15

a. Minimum rate of S.
b. Irrigated.
c. Solubor 20% B recommended at 5-10 kg/ha for all soils.

Fertilizer Research

Zambia's Ministry of Agriculture, through its Research Branch in the Department of Agriculture, maintains a network of 22 research stations in the nine provinces. The research work is coordinated through the soil chemistry section of the Mt. Makulu Central Research Station. The laboratories at Mt. Makulu have countrywide responsibility for conducting soil, chemical, and physical analyses and for providing soil advisory services including fertilizer recommendations. Since 1983 the Soil Productivity Research Programme (SPRP), headquartered at Misamfu Regional Research Station in the northern province at Kasama, has assumed similar responsibilities for the high-rainfall areas of Zambia (*10*).

Research findings have traditionally been reported in the Annual Research Reports of the Research Branch of the Department of Agriculture. Most work has involved applying science to local problems rather than investigations in fundamental science.

In addition to the Research Branch of the Department of Agriculture, the School of Agricultural Sciences at the University of Zambia has direct relevance to soil fertility and fertilizer research. The school is playing an increasing role in national research by carrying out fertilizer trials and also by training qualified Zambians to conduct fertilizer research.

The climate and soils in Zambia are well suited for growing a variety of crops; however, the natural soil fertility is generally low. Soil fertility constraints have been well studied and documented for major crops, such as maize, wheat, cotton, soybean, and groundnuts. Very little research work has been done on traditional crops, such as millet, cassava, beans, and sorghum.

Table 17. Response of Maize to Single Superphosphate on a P-Deficient Sandveld Soil at Magoye—Mean Yields of Single Hybrid SR 52 and Open-Pollinated Hickory King (*10*)

	Rate (kg P_2O_5/ha)				
	0	34	68	101	SE[a]
	------ (Yield [kg/ha])- -----				
After Sunhemp					
1963/64	3,942	6,028	6,758	7,394	150
1964/65	2,800	4,361	5,085	5,192	130
1965/66	5,466	7,258	7,276	7,311	186
After Maize					
1964/65	3,273	4,117	4,175	4,805	110
1965/66	4,222	5,676	5,654	6,263	161

a. Standard error + or -.

Nitrogen

In the early 1960s, an N-deficiency problem was acknowledged throughout Zambia. A favorable crop yield response to N fertilization can be expected on N responsive crops anywhere in Zambia provided that other nutrients are not the first limiting factor. For maize production, the optimum level of N in a good cropping season, at this time, is in excess of 134 kg/ha (*10*).

Phosphorus

The early fertilizer research in Zambia (1928-32) indicated that phosphorus was only deficient in virgin red clays at one site in the eastern province and in loamy sands in the southern and western provinces. Because of these studies, rates of applied P were kept at a low level. Long-term experiments were established to determine when nutrients would become limited under continuous cultivation. Phosphorus and potassium only became limited on Oxisols and Ultisols in the high-rainfall areas after 3 years. Recent correlations between soil test and yield responses have established the optimum levels of P fertilization for maize to be between 34 and 100 kg P_2O_5 on the P-deficient sandveld soils. A recent (1979/80) global study suggested 75 kg P_2O_5/ha as a corrective fertilization on the sandy soils of the Alfisol and Ultisol soil orders. Table 17 shows typical P response obtained on phosphate-deficient soils in Zambia (*10*).

Potassium

Potassium deficiencies are not considered to be a major problem in Zambia and especially where open-pollinated crop varieties are grown. On extensively cultivated soils and the Kalahari sands in the southern, western, and northwestern provinces, potassium deficiencies exist. Potassium fertilizers are recommended for maintaining an adequate K supply, especially where high rates of N are used and where high yields are anticipated (*10*).

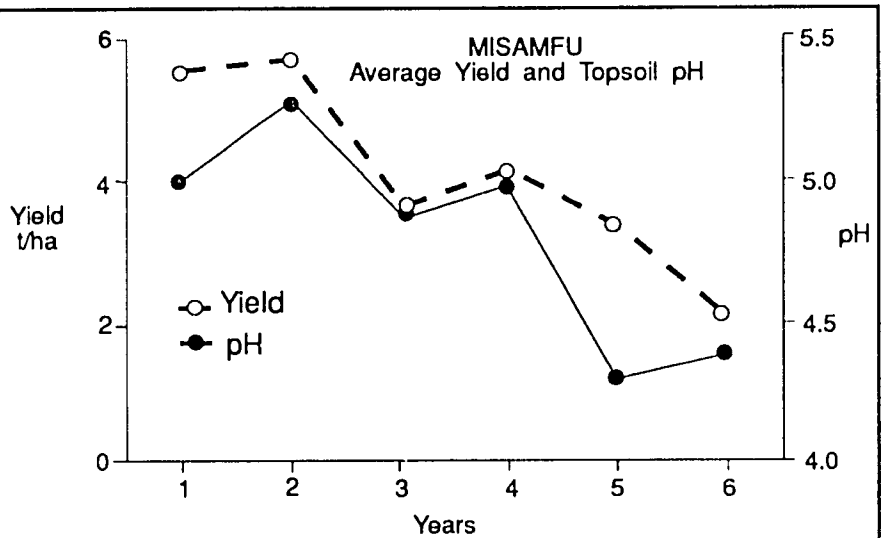


Figure 9. Maize Yield and Soil Acidity Relationships (*11*).

Soil Acidity, Calcium, and Magnesium

Soil acidity is one of the major factors limiting crop production in Zambia. Soil acidity prevents the farmer from receiving the full economic crop response from the fertilizers that are applied. The Ministry of Agriculture reports that soil acidity is evident in over 90% of the soil samples taken from rural areas where farmers complain of poor plant growth. The national mean pH value is 4.0. In a study of soils from 30 different countries, Zambia was second to Sierra Leone with the lowest mean pH value (*10*). Long-term liming experiments show a positive response to calcium, magnesium, and the elimination of excessive amounts of elements such as iron, manganese, and aluminum. There is also the benefit of stabilizing the pH at a desired level for nodulation of legumes and other bacterial actions.

Long-term liming trials carried out by the Department of Agriculture show a correlation of soil pH with maize yields. As the pH is reduced from 4.9 to 4.4, maize yields drop from 4.2 mt/ha to 2.0 mt/ha (*11*) (Figure 9).

Micronutrients

Micronutrient deficiencies in Zambia have been reported on some plants dating back as early as the 1960s. The extent to which deficiencies of these nutrients limit crop yields is generally not as well identified as it is for deficiencies of the major nutrients. Boron deficiencies have been reported on cotton, cauliflower, and wheat. Fertilizers used on boron-sensitive crops contain about 0.1% B (*12*). A zinc deficiency was reported on cotton at the Mt. Makulu Central Research Station in 1973.

In addition to boron and zinc, copper and molybdenum are considered to be generally low. Molybdenum deficiencies are associated with low-pH soils and with excessive levels of manganese. Where a liming program is followed, neither molybdenum nor manganese toxicity is a problem (*10*).

Future Fertilizer Research

Research has shown that soil fertility and thus crop production can be maintained for up to 10 years or more in the low- to medium-rainfall areas in Zambia with moderate rates of fertilizer application. Research also indicates that with higher rates of fertilizer use and proper liming, monocropped maize can be maintained up to 15 years. However, in the 700- to 800-mm rainfall areas of central, southern, and eastern provinces, research and farmer experiences have shown that production declines rapidly under cultivation in only 4 to 5 years. The use of high rates of lime and CAN does not prevent the decline from an economical maize yield of 4.5 mt/ha after the first 2 years.

The high cost of fertilizers in Zambia has alerted researchers to the need for increased efficiency of fertilizer use. Future research will focus on the possibility of integrating weather, soil, fertilizer indices, yield, and other input data into a common data base to improve yield predictability by soil types. The need to investigate the potential use of indigenous agrominerals for fertilizer production has also been identified.

Extension Service

The extension service in Zambia is organized and operates under the Ministry of Agriculture. Through its various programs and in cooperation with such organizations as the Food and Agriculture Organization of the United Nations and Global 2000, one of its main objectives is to transfer fertilizer use technology. The extension service is organized by subject matter as follows:

1. Crop husbandry.
2. Animal husbandry.
3. Horticulture.
4. Farm management.
5. Planning.
6. Agriculture engineering.

At the provincial level, the agricultural department is headed by a provincial agricultural officer. He is supported by subject-matter specialists. Under the nine provinces, there are 59 districts. There is a district agricultural officer in each district with a support staff similar to that of the principal agricultural officer. Each district is divided into about 20 wards, for a total of 1,197 in Zambia. There are 1,900 agricultural camps for farmer training. Farmers are assigned to one of the camps. The entire organization employs 3,000 extension officers. Of this total, approximately 750 officers are assigned to the national- and provincial-level programs, and 2,250 are assigned to the district, block, and camp programs.

Field days are arranged at different stages of crop growth with activities directed to demonstrating proper crop management practices, which include the efficient use of fertilizers. In addition, under the Lima plan, courses are conducted to give peasant farmers an introduction to fertilizer use (*11*).

Extension officers are provided information on fertilizer recommendations for specific crops through the Mt. Makulu Central Research Station. Scientists stationed at Mt. Makulu collect information from the other research stations for guidance in determining the recommendations. Although the fertilizer recommendations are based on crops and varieties, they are not area-specific. The farmers generally follow the extension service recommendations for types of fertilizer although the rate of application is often less than that recommended.

Soil analyses are not generally used in determining the nutrient requirement for individual farms. A farmer, wishing to get his soils analyzed, has to take the samples and deliver them to Mt. Makulu, the only laboratory that will analyze samples for farmers. In practice, this has caused a situation where only commercial farmers use this analysis service.

Extension agent demonstrating hand tools to farmers.

Fertilizer Raw Materials

The full potential for agrominerals in Zambia has not been determined. The presently known indigenous minerals that may be used for agricultural production in Zambia are (1) phosphate-bearing rocks (Figure 10), (2) sulfur-bearing rocks and byproduct gases, (3) limestone (Ca- and Mg-bearing rocks), (4) peat, and (5) other soil conditioners (zeolites, smectite clays). There are no known evaporites within the Zambia geological succession and therefore no commercially viable mineral sources of potash.

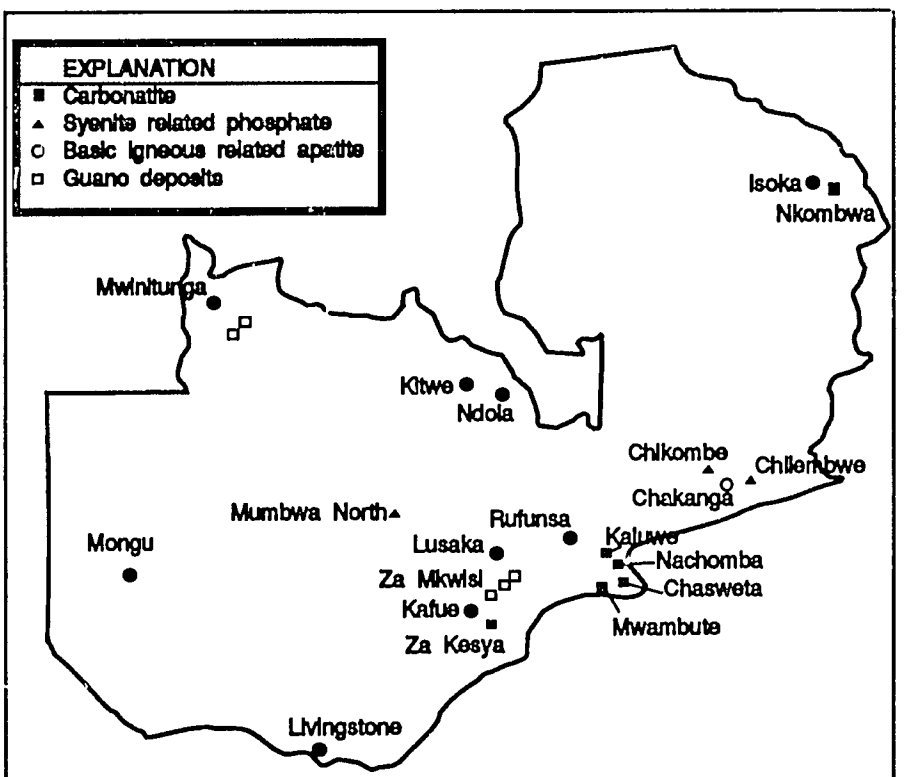


Figure 10. Zambia Phosphate Prospects.

Phosphate exploration in Zambia, until recently, has focused on carbonatites. For the most part, the carbonatites are very ferruginous and heavily impregnated with siliceous materials. There are at least five such deposits in Zambia. Four deposits are grouped in the Rufunsa Valley. The largest is at Kaluwe. The Kaluwe deposit is a sill or accumulated series of carbonatite lavas estimated to be 250 m thick at the highest point and covering 15 km^2 (*13*).

Extensive geological investigations have been conducted on the Kaluwe body. Total reserves of phosphate-bearing rocks at Kaluwe are estimated as 207 million mt at 2.5% P_2O_5 using a 0.5% P_2O_5 cutoff grade. In selected areas, 7 million mt with 3.2% P_2O_5 and 21 million mt at 2.9% P_2O_5 have been delineated. The low grades render the deposit uneconomic using conventional technology and under current market conditions (*14*).

Separate estimates have been made for the loose weathered materials occurring as elluvial and alluvial soils bordering and filling depressions within the Kaluwe body. The soil resources were estimated by two different methods indicating 6.6 million mt at 5.11% P_2O_5 by one method and 10.8 million mt at 4.14% P_2O_5 by another method. Selected parts of the soils seem to contain higher phosphate concentrations (approaching 10% P_2O_5). A new evaluation of selected parts of soil deposits is being initiated. The rocks are to be tested for direct application use or, if grades are sufficiently high, for industrial use at commercial fertilizer plants (*14*).

Another carbonatite phosphate is the Nkombwa Hill deposit located in northeastern Zambia approximately 25 km southeast of Isoka township along the Zambia-Tanzania road. The location of this deposit along a major road gives it an added benefit over those deposits which are more remotely located.

The carbonatite forms a distinct hill rising about 300 m above the surrounding plain. The lateral dimensions of the hill are about

15 x 2.5 km. Only in the 1980s has exploration been directed toward assessment of its phosphate and lime potential.

Composite values from bulk rock samples have shown P_2O_5 levels from 3% to 8% with a very erratic distribution. Surrounding and overlying soils give fairly consistent levels of about 8% P_2O_5. However, much of the phosphate resource at Nkombwa is in the mineral isokite ($CaMgPO_4F$). Isokite is not considered to be amenable to practical beneficiation and fertilizer manufacture.

Two other small bodies which may be carbonatite are Kesya and Mkwisi located 60 and 35 km southeast of Lusaka, respectively. There is no detailed economic appraisal of these deposits on record (*13*).

Mr. Davidson Mulela, Senior Geologist, Zambia Industrial and Mining Corporation Limited (ZIMCO), in a Mumbwa North phosphate deposit trench preparing to take a sample.

Emphasis in phosphate exploration has shifted in the past decade from carbonatites to syenite-related bodies. The Mineral Exploration Department (MINEX) discovered a group of these at Chilembwe. The Chilembwe is the best known phosphate deposit in Zambia. Regional geochemical surveys have located areas with moderately high phosphate contents. Five bodies have been discovered at Chilembwe. Initial interpretation was that they were of entirely igneous origin. However, recent petrographic studies of the apatite grains suggest reworking by sedimentary processes. An economic appraisal of the three largest bodies using 6% grade cutoff and ignoring bands of less than 1-m thickness indicated 1.7 million mt of average grade ore with 12.3% P_2O_5, mostly coming from the largest body. A prefeasibility study indicated that operation of a small phosphate mine at Chilembwe producing 10,000 mtpy of 30% P_2O_5 concentrate would deplete the deposit in 15 years (*13*).

The Mumbwa North and Sugar Loaf deposits, located about 160 km west of Lusaka, are situated in a geological situation analogous to that of the Chilembwe deposit. The iron content in all the Mumbwa North samples is above the level that is acceptable for fertilizer manufacture. Additional research work is needed to establish the required information on these deposits, and exploration is being continued (*14*).

The survey of Sugar Loaf plug indicates possible reserves of 0.5 million mt of ore at the approximate grade of 8%-12% P_2O_5, using 5% cutoff. The other bodies are smaller. The largest of "pegmatitic" occurrences are estimated to contain approximately 0.2 million mt with an average grade of 16% P_2O_5 (*14*).

Sulfur plays a large role in Zambia's fertilizer industry. Most of Zambia's primary sulfur resource is in the form of sulfide mineralization, but there are also reserves of natural and byproduct gypsum. Supply to the agricultural industry is, at present, from the Nampundwe pyrite mine 48 km west of Lusaka and, as gypsum, from the Chambishi Cobalt Plant. The sulfuric acid demand is primarily met internally by the copper industry; Nkana Division has a capacity of 305,000 mtpy from its four acid plants, and Chambishi has a capacity of 75,000 mtpy from cobalt roaster offgases. Only the gases from the Nkana and Chambishi smelters are captured. Those from Luanshya and Mufulira are allowed to escape. These could be additional sources of sulfur.

The lodes in the Nampundwe deposit range up to 20 m in thickness and are separated by 5 to 50 m of weakly mineralized dolomite. One lode is

mainly pyrite; the other contains minor copper. Reserves to the bottom of the 220-m shaft are currently some 10 million mt averaging 16.8% sulfur and 0.7% copper with equal reserves indicated below that level. The mine has recently been expanded to treat 280,000 mt of ore per year, grading at 12% sulfur and 0.4% copper, from which it can make up to 70,000 mt of concentrate. It supplies both the Copperbelt and NCZ according to demand. Currently, the requirement of the fertilizer factory, which has its own acid plant, runs below 30,000 mtpy.

Other possible sources of sulfur are found in the pyrite that occurs as fringes to copper lodes. They grade at 2%-3% sulfur. Mixed sulfide mineralization, though of much lower grade than at Nampundwe, has been delineated in eastern and western provinces. Maamba coal carries about 2% sulfur (mainly in the form of pyrite) from which it could supply about 500 mt of sulfur a year, if required, from its estimated reserve of 18 million mt of coal. The Kabwe lead-zinc mine has 36,000 mt of pyrite concentrate with 40% sulfur.

Sulfur sources also occur in gypsite within the superficial deposits of the Kafe Flats and Siloana Plain in the western province. They are worked commercially at Lachinvar where gypsum constitutes 20% of the sediment. Gypsum can be applied for a source of calcium and sulfur and also as a soil conditioner, especially where sodium accumulations are a problem (*13*).

Limestone and dolomite sources to reduce the soil acidity and supply calcium and magnesium have good potential for development in Zambia. Sedimentary or metasedimentary carbonate rocks underlie much of central Zambia. They occur in a broad north-south belt stretching from the northwestern province to the Monze District. Most are compositionally suitable for agricultural application where the minimum MgO content required is 6%.

On either side of this belt, carbonate rocks are much less abundant although there are some in every province. In the past, exploitation of carbonate rocks seems to have been influenced by needs for cement raw material and aggregate supply rather than for agriculture. The emphasis therefore has been put upon developing the calcitic deposits close to urban areas, notably at Lusaka, Kabwe, and Ndola. Apart from some minor quarrying in the eastern province, virtually all agricultural lime and limestone supply has come from these centers. There is a need to reduce long and expensive lines of transport from these quarries to reach the smaller farmers in outlying areas. Two areas under investigation are Chivuna near Mazabuka and Munsakamba near Mkushi. There are many suitable sites that offer quality and quantity and need to be studied for possible development (*13*).

Peat for soil conditioning and as an additive is available in Zambia. Peat can be used to increase the humus content of soil. It is also important in nursery beds and for special horticultural needs. Deposits of peat are known in several areas in Zambia. Although little has been done to quantify reserves, peat is abundant and widespread.

Recent research has shown that zeolites and sodium bentonites prove most useful in soil as storage and slow-release agencies of vital cation nutrients such as phosphorus. No natural concentrations of zeolites are known in Zambia. Bentonitic clay horizons do occur in the Madumabisa Mudstone of the Luano Valley. This material is presently under investigation for its potential in vegetable oil clarifying. It could conceivably be of some value as a soil additive after suitable treatment.

Fertilizer Consumption Forecast

As indicated in previous sections, fertilizer use has fluctuated dramatically during the past 8 years; total nutrient use declined in 5 of those years. Reasons for the year-to-year variation in use are not fully known, but fluctuation is linked to (1) supply shortages and late arrival of fertilizers, (2) pricing developments, (3) unfavorable weather conditions, and (4) delays experienced by farmers in receiving payments for crops. A trend analysis based upon these data would be insignificant. The compound growth rate in fertilizer sales for the past 8 years has been less than 2%. This is extremely low for an agriculturally based economy such as Zambia where the fertilizer market is in an early stage of development.

Farmers in Zambia are generally aware of potential benefits from using fertilizers. Recent policy decisions by the Government indicate that increased emphasis is being placed on improving efficiency in the marketing system in terms of improved supply availability, reduced losses, and lower costs. The Government has given NCZ the responsibility for supplying and marketing of fertilizers in Zambia. NCZ is implementing a marketing system based on private sector concepts. In addition, NCZ has indicated that increased attention will be given to promotional activities designed to promote fertilizer market development (*6*). IFDC's experience in similar markets suggests that fertilizer use in Zambia should easily increase by 8%-10%/year over the next few years, given adequate supply availability, a continuation of the existing fertilizer:crop price relationship, and favorable weather. Hence, fertilizer use in 1993 would total about 330,000 mt of product or 129,000 mt of nutrient (Table 18).

For comparison purposes, the most recent fertilizer demand forecast by NAMBOARD, prepared in 1988, assumed that consumption would increase by 6.6%/year for the next 5 years and total 266,000 mt in 1993 (Table 19). Both the assumed annual growth rate of 6.6% and NAMBOARD's estimate of apparent consumption in 1988 (i.e., 200,000 mt) appear to be conservative (*6*).

Little change is expected in the future product mix used by Zambian farmers. The predominant basal dressing fertilizers will be compounds "R," "X," and "D", with compounds "X" and "D" being the most popular. Urea will continue to grow in importance as a topdressing material, primarily because importing urea has an economic advantage over importing low-analysis nitrogen products. The future role of ammonium nitrate as a topdressing material will, to a large extent, depend upon the resumed operation of the NCZ factory. Ammonium nitrate production that is surplus to Zambia's explosive-grade ammonium nitrate requirements for mining will be used in agriculture.

Table 18. Forecast of Fertilizer Consumption in Zambia, 1988-93 (*6*)

Nutrient Tons	Estimated 1988	Forecast 1989	1990	1991	1992	1993
	('000 mt)					
N	56.4	61	66	71	77	83
P_2O_5	22.8	25	26	28	31	33
K_2O	8.5	9	11	11	11	13
TOTAL	**87.7**	**95**	**103**	**110**	**119**	**129**
Product tons	225	243	262	283	306	331

Table 19. Five-Year Fertilizer Demand Forecast, 1989-93

Product /Year	1989	1990	1991	1992	1993
	(mt of product)				
Nitrogen					
Urea	55,000	50,000	40,000	45,000	50,000
Ammonium nitrate	30,000	40,000	55,000	60,000	60,000
Compounds					
"D"	42,000	44,000	46,000	48,000	50,000
"X"	53,000	54,000	59,000	60,000	62,000
"R"	21,000	22,000	23,000	24,000	25,000
"C"	6,000	7,000	7,000	8,000	8,000
"V"	4,000	5,000	5,000	6,000	6,000
Others	4,000	4,000	5,000	5,000	5,000
TOTAL	**215,000**	**226,000**	**240,000**	**256,000**	**266,000**

Note: Fertilizer year covers a period of 12 months commencing on October 1 and ending on September 30.

Source: National Agricultural Marketing Board, 1989.

Concluding Comments

Zambia is a vast country with a tremendous potential for agricultural production; converting that potential to actual performance is essential to the future of the country. The agroecological conditions in Zambia are well suited to crop production. The adaption of known technology for increasing crop yields is needed. The Government has recently implemented a number of policy measures, including a provision for crop production incentives, which should lead to improved efficiency in agricultural production.

Improved performance in the fertilizer sector will help promote efficiency in agricultural production. Fertilizer marketing has been the focus of a number of Government policy measures as related to fertilizer sector development, including encouraging private sector involvement in fertilizer marketing. On the one hand, reducing physical losses, "leakage" across the border, and marketing costs is essential to achieve reductions in retail fertilizer prices to farmers. At the same time, the marketing system must deliver to a convenient location the appropriate types of fertilizers when the farmer needs them.

It is critically important to address the soil acidity problem that is present throughout much of Zambia. This is essential for achieving sustainable increases in agricultural production. The marketing of crop output must be improved. There is also an ongoing need to upgrade fertilizer recommendations to meet the nutrient requirements of the crops and soils in the major agricultural regions. Finally, the potential to use indigenous raw material and locally available byproducts in fertilizer production should be fully evaluated.

Maize yields in Zambia can be outstanding.

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