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FERTILIZER SUPPLY AND DISTRIBUTION
- ISSUES AND CONSTRAINTS -

Planning Division, Ministry of Agriculture
and
Water Development, Lusaka; Zambia

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I. INTRODUCTION

The Government of the Republic of Zambia recognizes the important role fertilizer plays in the production of Zambia's food crops and the realization of food self-sufficiency. Concern has been expressed by many in Government over the poor performance of the fertilizer supply system in providing producers the required quantities of appropriate fertilizer in a timely fashion. Because of the relatively large amounts of fertilizer imported , compared to levels of production (particularly the staple, maize), questions have been raised as to what happens to all the fertilizer and the implication for cost in foreign exchange earnings. There is concern for possible waste from misapplication at the farm level and the implication of fertilizer use on highly acid soils. Questions have also been raised as to an appropriate institutional framework for managing the system, the use of different handling techniques to improve efficiency and the efficacy of current fertilizer recommendations by research.

Because of the importance and urgency of these questions, the Planning Division of the Ministry of Agriculture and Water Development (MAWD) conducted a study of the fertilizer subsector during the period of June 25 to July 23, 1988. Economists of the Planning Division were assisted by staff from the National Agricultural Marketing Board (NAMBOARD), the Department of Marketing and Cooperatives, and fertilizer specialists from the International Fertilizer Development Center (IFDC), The United States Agency for International Development (USAID) and Iowa State University to address the problems faced in the subsector.

Unavoidable circumstances including a death in one specialists'

family and two national holidays (July 4th and 5th) reduced the effective work period of the study. The team therefore limited the main focus of the study to the following objectives:

1) document issues and constraints of Zambia's physical distribution systems;
2) evaluate the existing system for supplying both local and imported raw materials and finished products;
3) estimate nutrient and product use in 1986 and 1992;
4) make an assessment of current products used ;
5) Develop terms of reference for an in-depth study to include information gathering, analysis and the preparation of a plan of action for the development of an efficient fertilizer system.

Methodology of the study involved the team collecting data from previous studies, the Central Statistics Office (CSO), National Agricultural Marketing Board (NAMBOARD), Cooperative Unions and the Bank of Zambia. Key persons at these and other institutions were interviewed. For information on fertilizer research and development, scientists were interviewed at the Central Research Station at Mt. Makulu and the Regional Research Station at Kabwe. (This included members of the Adaptive Research Planning Team stationed at Kabwe.) Field visits included individuals at NAMBOARD regional offices and Cooperative Unions in Central, Southern and Eastern Province. National, provincial, district and rural depots and handling facilities were visited as well. Large scale and small scale commercial

farmers and a few emergent farmers were interviewed to determine constraints they faced in fertilizer use.^^

The following report documents the physical distribution system including the identification of current bottlenecks to efficient operation and the estimate of physical losses sustained. The currently fragmented institutional mechanism for managing the system is challenged. In addition, the report provides insight to the implications of continued use of current fertilizer recommendations. It highlights the key role of education at all levels including the promotion of fertilizer and the development of appropriate application techniques at the farm level.

The study suggests a number of alternatives, which could break bottlenecks and reduce the fertilizer losses occuring in the system. Time and information constraints faced by the study team do not permit adequate analysis to provide a recommended course of action in this report. In addition, the magnitude of the documented losses to the Zambian economy and the technical nature of the revealed constraints provide a rationale for further in-depth investigation and analysis of the fertilizer supply and distribution system. Such a study would of necessity be multidisciplinary in nature and would require interministerial cooperation. The report therefore provides scopes of work for the recommended in-depth study, which would result in a recommended plan of action for the development of an efficient fertilizer marketing and supply system.

^^ Footnote: Large scale - greater than 40 Ha. (Includes one farm over 2000 Ha.). Small scale commercial - 6 to 40 Ha. selling most of production. Emergent farmers beginning to use improved techniques including fertilizer application.

II. SUMMARY

THE FINDINGS

A. CONSUMPTION

Fertilizer consumption has increased 58% in the last 7 years. From 133,695 metric tons sold by NAMBOARD in 1975, consumption increased to 211,864 metric tons in 1982. (Most of this consumption was imported.) According to figures supplied by the World Bank, economic cost of fertilizer delivered to the rural areas has increased by 58%, during the same period. Despite the above, Zambia still ranks relatively low in terms of application rate per hectare of arable land and permanent crops.

This increase, combined with the increase in volume used, has raised the total price tag of fertilizer delivered to the farmer from approximately 44 million Kwacha to 98 million Kwacha, an increase of 125%. This represented a foreign exchange cost to Zambia of 74 million Kwacha in 1982, which in turn has serious implications for the economy from losses sustained as a result of an inefficient marketing and supply system.

Historical trends are used as a basis for projecting fertilizer requirements to 1990. These rough projections place the 1990 fertilizer requirements at approximately 400,000 metric tons. Supply and delivery of this volume of fertilizer will require a much improved system of marketing and distribution. A number of factors could influence the actual requirements either up or down from these projections. This report reviews a number of ways an improved system could reduce the fertilizer requirements for a given level of productivity. Improved application techniques at the farm level and

other factors could also reduce these requirements.

The comparison of maize production statistics to level of fertilizer sales has raised concern of many because of a relatively low level of production compared to fertilizer used. However, this may be misleading. The team found evidence that fertilizer is being used for other cash crops as well as for pasture improvement.

Investigations were made to determine whether or not fertilizer is available to small scale producers and how they are using it if available. The study team visited with a number of small scale producers, extension officials, management of cooperatives and scientists of the University of Illinois ARPT team at Kabwe. Results of these investigations show that the small scale producers have fertilizer available, but lack of adequate resources may hinder them from obtaining and using their fair share. Analysis of records provided by the Chinjara Settlement Scheme revealed that application rates tend to fall in a "low/medium" management level, but yield response is substandard, indicating a need for improved management techniques resulting from an improved fertilizer education program. This evidence is supported by a groundnut subsector study and survey of 76 small scale farm units in Eastern Province, carried out by the Planning Division of the Ministry of Agriculture and Water Development with assistance from the Iowa State University technical assistance team in March, 1983. Problems reported of timeliness and availability of the "right" fertilizers reflect the inefficiencies of the current distribution system.

B. PHYSICAL DISTRIBUTION

Due to the chemical and physical nature of fertilizer, excessive manual handling of individual fertilizer bags causes quality deterioration and physical loss at each point in the distribution chain. This is true for both locally produced and imported fertilizer. The current system of manually handling of Zambia's fertilizer requires 30 transfers from port to consumer, due to the distances from ports and the numerous distribution points through which the fertilizer passes. Based on accepted standards of 0.5% loss per transfer for mechanically moved fertilizer, an estimated 0.8% loss with each manual transfer can be expected. The 30 manual transfers thus yield an expected minimum 24% physical loss of fertilizer in the system. Additional losses in storage etc. increase the losses to an estimated 30%. The team attempted to further document losses through an analysis of inventories and sales at NAMBOARD and the three marketing cooperatives which sell 80% of the fertilizer. NAMBOARD and Southern Province Cooperative Marketing Union provided excellent data and insights into the question. However, the overall effort was thwarted by lack of cooperation on the part of Central Province Marketing Union and Eastern Province Cooperative Union in providing the needed records.

Several alternatives for improved handling, storage, transport and accountability could reduce loss levels to as low as 5%.

HANDLING - A system should be designed for moving fertilizer to minimize transfers and reduce losses by more direct routing to the final destination and unitizing (either in bag or bulk). Among the alternatives for minimizing transfers are: (1) palletizing and covering with a plastic wrap ("shrink-wrapping") at the manufacturing

site for shipping as palletized units; (2) shipping in bulk to ports of entry where bagging, palletizing and shrink-wrapping occur before on-shipping; (3) shipping in bulk to bagging sites located at optimally determined nodes in the distribution system; (4) shipping intermediate fertilizer products to bulk-blending facilities where various grades of fertilizers can be physically mixed and bagged. Each of these and other alternatives has technical, economic, educational and policy implications which require further detailed study before selecting a strategy appropriate to Zambia's input supply system.

STORAGE/FACILITIES- Observations made at provincial, district and rural depots revealed fertilizer storage to be inadequate in quality and quantity. Lack of appropriate storage facilities contribute to physical and financial losses and inhibit the timely supply of the appropriate quantity and quality of fertilizer to the farmer.

Due to lack of adequate permanent facilities, both Hamboard and the cooperatives often stack fertilizer in the open on the ground or on raised concrete platforms ("hardstands"), protecting the stacks with tarpaulins and moisture barriers. Inadequate protection creates losses. This problem is particularly acute at the rural depot level but exists at regional and district levels as well.

A long and unreliable supply system creates need for inventorying larger than normal buffer stocks for longer than desireable periods of time at transhipment points. This adds to the demand for more storage facilities. The relatively low analysis fertilizers (Percent of nutrient is low relative to amount of carrier in the fertilizer. See PRODUCTS section below.) currently in use in Zambia also increase the overall storage capacity required at these points. Projected increases in fertilizer use will add to this problem. A shift to higher analysis

fertilizer products could reduce covered storage requirements.

Provincial cooperative unions typically do not move fertilizer from NAMBOARD warehouses during the dry season because of (1) a lack of secure facilities at rural depots, (2) the maize procurement process, (3) a lack of funds for fertilizer purchase and (4) the facility of shipping directly from the NAMBOARD storage to rural depots during the early rainy season. This procurement practice short-stops the smooth flow of product, and increases storage requirements and costs to NAMBOARD. It also eliminates the chance for farmers to purchase fertilizer when they sell their maize crop, and increases the chances that they will not have the fertilizer when they need it.

The fertilizer marketing system needs more secure permanent storage. The Canadian International Development Agency (C.I.D.A) has built ten permanent storage sheds at NAMBOARD regional depots in Southern Province and Eastern Province. The sheds, totaling 38,500 metric tonnes of new storage should greatly improve the storage situation at the regional level.

A number of other donor agencies are also interested in providing storage facilities for both maize and fertilizer. A World Bank plan to provide secure buildings at 60 of 400 rural depot sites in Southern Province is an example. Priority should be placed on putting this storage at the rural depot level to make possible the more direct shipment of the bulk of fertilizer volume to locations close to final user. Decisions relative to size, nature of construction and location of any storage facility should await a full study and the approval of an action plan for the entire fertilizer system.

Special contractual arrangements between NAMBOARD and the Cooperatives need to be arranged to make direct shipment to rural

depots possible. This would reduce costly transfer and storage costs in the pipeline and would make the fertilizer available to the farmer when he has the cash at maize marketing time.

STORAGE/PRACTICES - Storage practices frequently observed contribute significantly to the physical loss and quality deterioration of fertilizer products.

Stacking bags of fertilizer beyond 16 layers high causes pressure damage to fertilizer in the lower layers. This practice seems most severe in permanent storage locations. Managers at NAMBOARD depots at Lusaka, Choma and Monze were observed stacking fertilizer up to 44 layers high to maximize the amount under permanent cover. Commonly, fertilizer is also stacked too high in the outdoor sites.

In permanent warehouses, appropriate procedures for providing adequate air flow and humidity control are not followed. For example, managers typically stack fertilizer bags directly on the concrete floor, instead of on dunnage or pallets, increasing the potential for moisture damage to the lower layers.

The organization of the location of stocks often increases the amount of manual movement required for receipt and dispatch of fertilizer. At many locations served by rail sidings, storage is located away from the sidings. The newly commissioned NAMBOARD warehouse in Choma is an exception where off-loading directly from the rail siding is possible.

Stock record keeping was in evidence and should be encouraged. More frequent reporting of stocks by the cooperatives to NAMBOARD could enhance the capacity to plan procurements. Independent and unannounced on-site verification of stocks should be practiced.

Many of the observed practices point to the need for an

educational effort to teach depot managers appropriate storage techniques.

TRANSPORT - Most fertilizer ingredients and finished products are shipped by rail from seaport to Zambian destinations in open gondola cars covered with tarps. Exposure to weather and lack of security of this means of transport cause losses in route, which NAMBOARD records place at 5%. Bunching of import arrivals at port in a relatively short time span, delays in railway allocation of rolling stock and a government requirement that NAMBOARD use trucks for part of the shipping from port cause serious delays in moving fertilizer away from port. This results in high storage/demurrage charges, extra handling losses and discontinuity of shipment to final destination.

NAMBOARD sustains all shipping losses from port to destination. Because NAMBOARD accepts title at the port, neither the forwarding agent nor the railroad authority accept responsibility even though the fertilizer is in their physical control. Such a system is a disinsentive to efficient movement of the product.

Because of the relationships between scheduling, modes of transport, transfer of titles, the methods of handling and the storage system a more complete study and analysis is required to design a complete physical distribution system for Zambia's fertilizers.

C. PRICES

The price of fertilizer in Zambia is an administered price (set by the GRZ) and as such is a very important instrument in effecting government policy. In the Zambian context, fertilizer price has historically reflected the desire of Government to stimulate food production on the one hand without unduely increasing costs of food to

consumers on the other. The fertilizer price also reflects Zambia's choice to invest heavily in the development of its own fertilizer production at Nitrogen Chemicals of Zambia Ltd.. Government subsidies to the farmers, users and ultimate beneficiaries of fertilizer use have therefore been a heavy burden on the Zambian economy, a burden which has had to be re-evaluated in the recent economic situation.

RECENT TRENDS AND IMPACTS - The nominal price farmers pay for fertilizer has gone up 268 per cent in the last 7 years, while the price farmers received for maize went up 209 per cent. The price of fertilizer has not seemed to dampen fertilizer consumption. However, in the latest gazetted prices, the price of maize increased only 14 per cent while the price of fertilizer increased by more than 60 per cent. This was a reflection of the 20 per cent devaluation of the Kwacha and the partial removal of fertilizer subsidies.

During a number of interviews with farmers, Extension staff and researchers on adaptive research planning teams, the issue of the large increase in fertilizer price relative to the increase in maize price was raised for discussion. There was a general feeling among these experts that the new fertilizer prices will discourage some small farmers from using fertilizer. This judgement was based on the increase in the perceived risk the small scale farmer with limited resources feels he is taking when he invests so heavily in fertilizer.

From budgeting analysis done by the study team it can be concluded that the higher relative price of fertilizer to maize will most likely influence some farmers, both small scale and large scale, with relatively low yields and higher costs per unit produced to shift production to other more profitable crops. On the other hand the efficient producer with high yield levels will find maize production a

very profitable enterprise despite the sharp increases in fertilizer price. There is an increased incentive toward higher yields and improved efficiency with the new price relationships.

UNIFORM PRICING OF FERTILIZER - Fertilizer price should provide adequate incentive to move fertilizer efficiently through the distribution system. The currently fixed and uniformly administered pricing structure does not reflect any of the value added by various activities as the fertilizer moves through the system. Likewise, there is no means of determining whether or not a given portion of the distribution system is performing well without comparing the value added at that point in the system with the cost generated there. Receiving a rebate for costs incurred, and receiving that at a date long after the costs are incurred is a disincentive to the rapid and effective movement of fertilizer.

Under the current system, the cooperatives have every incentive to minimize costs by delaying purchase and movement of fertilizer until the latest possible time. This strategy reduces holding inventory, maintaining storage facilities and accepting the financial responsibility for the product. The system forces the movement of fertilizer at a non-optimal time. It causes back-ups and stock-piling in the NAMBOARD portion of the system. The resulting delays in the arrival of fertilizer to the rural sales centers can be very costly in decreased farmers' yields.

D. FERTILIZER PRODUCTS

COMPOUNDS - Only five compound fertilizers and two nitrogen products are available to meet the diverse soil and crop conditions faced by Zambian farmers. Based on some research showing a widespread need for sulphur, all basal fertilizers sold in Zambia are required to contain

10% sulfur. These sulphur containing fertilizer compounds are expensive to produce, costing Zambia a premium, since they are not commonly in demand elsewhere. They are low in nutrient analysis by modern standards.** They are also subject to more rapid chemical and physical deterioration. The limited selection of nutrient combinations these fertilizers provide inhibit the farmer tailoring nutrient application to soil needs. This often leads to both under and over application of nutrients.

One alternative for further study lies in the physical blending of high analysis products tailored to site-specific soil and crop conditions. By adapting the high analysis alternative, the total tons to be handled by the supply and distribution system would be cut by 30%, significantly reducing cost as well.

** Footnote: This refers to the percentage of active ingredients (in particular the main nutrients, nitrogen, phosphate and potash or N-P-K) in the fertilizer as compared to the amount of material used for carrier.) An example of low analysis fertilizer would be compound "R" with an N-P-K of 20-20-0 or compound "D" with an N-P-K of 10-20-10. This compares with the high nitrogen fertilizer urea, which has an N-P-K of 33.5-0-0 or one of the high phosphate fertilizers with an N-P-K of 18-46-0.

Among other alternatives to be studied are the use of sulfur coated urea for top-dressing and the blending of prilled sulfur in the basal mixture.

LIMESTONE - Zambia's agronomic research recommendations call for application of dolomitic limestone to affect the naturally acid soils and the increasing acidity caused by repeated application of fertilizers containing nitrogen and sulfur. Crop response to fertilizer application will progressively diminish and soils will eventually become irreversibly damaged (incapable of growing row crops economically) without the use of lime.

A need exists to plan a course of action with implementing proposals for the production and distribution of agricultural grade limestone.

E. RESEARCH AND DEVELOPMENT

RESEARCH - Fertilizer Research has been conducted in Zambia for more than 25 years. Most data has been obtained from formal experimentation at research stations. To date, no crop yield response curves specific to individual fertilizer nutrients have been published. Such response curves are essential to planning fertilizer procurement as well as the making of accurate recommendations. Current fertilizer recommendations exist in the form of lime, 5 compounds for basal application and 2 nitrogen products for topdressing. While these recommendations may be adequate to introduce fertilizer use to small farmers, they limit the efficient use of fertilizer nutrients.

Research is needed on new products such as sulfur coated urea, application of straight materials and banding versus broadcasting application of phosphates. Research is needed on farmers' fields to

provide information under field conditions and to allow for the adoption of practices which make maximum use of each plant nutrient.

FERTILIZER EDUCATION - The Extension Service of the Ministry of Agriculture and Water Development has sole responsibility for fertilizer education. Crop production programs including information on fertilizer use have been a part of extension efforts for a long time. The Lima Program is currently the Extension Service's principle program for providing fertilizer education along with information on other cultural practices for crop production. The Extension Service is hampered in their educational efforts by low staff to farmer ratios, limited mobility, insufficient and untimely supply of fertilizers and for many of the staff, a lack of adequate technical knowledge of fertilizers.

A new program called " The National Lima Fertilizer Program " has been recently instituted. This program supported by FAO and other donors is designed to improve extension's delivery of information about fertilizer to the small farmer by providing Extension with adequate resources and training of manpower. Current enrollments of farmers for participation this coming crop season are encouraging. In addition, the program is designed to provide a growing data base of fertilizer use by the small farmer. This program needs to be encouraged.

Marketing agencies in Zambia are not involved in the fertilizer education process, yet the rural depot manager should be the front line of educational effort, since he is the last person to talk with the farmer on farming practices before he goes to the field and applies the inputs. First hand knowledge of what is happening in the field also provides feed-back to the market system for improving delivery and customer satisfaction and for the planning of fertilizer procurement.

F. ORGANIZATION

Zambia's marketing and supply system suffers from a multiplicity of agencies being involved in decisionmaking and in execution of its marketing functions. (Section VI gives the major institutions involved and their roles.) This fragmentation has been amplified by the new relationship between NAMBOARD and the cooperatives. The GRZ has shifted responsibility for rural distribution of inputs and procurement of commodities from NAMBOARD to the provincial cooperatives. There has been a resulting break-down in communication, financial flows and the chain of responsibility impeding the smooth flow of fertilizer to the farmer. In addition, various donor groups are endeavoring to assist with the development of the fertilizer system. Lack of overall coordination impedes accurate and timely decisionmaking. Information flows and financial flows essential to procurement and timely delivery of fertilizer to the farmer are often hindered.

This points to the need for an organization specifically structured to manage the marketing and supply of fertilizers. This organization should be provided with enough autonomy to carry out all the marketing functions. It should be held accountable for putting the right product at the right place, at the right time and for helping to insure its correct use.

RECOMMENDATIONS

This study has identified a number of existing constraints which result in excessive losses in the fertilizer marketing system and undue cost to Zambia's economy. These losses being sustained point to the urgency for taking action to plan and implement an improved fertilizer marketing system. A number of alternatives have been suggested which could alleviate these constraints. Each of these and other alternatives has technical, economic, educational and policy implications which require further detailed study and interaction with policy makers, before selecting a strategy appropriate to Zambia's input supply system. Following are the recommendations proposed:

A. MAIN RECOMMENDATIONS

1. that a more detailed study and analysis be conducted including the development of a plan of action for the design and implementation of an improved fertilizer marketing system. Such a study should take into account all the technical, economic, educational and policy implications of alternative strategies which might be followed. A three-step approach to the development and implementation of the needed action plan for an efficient fertilizer marketing system is proposed (Refer to Terms of Reference Annex C):

a. collect data needed to prepare a comprehensive action plan for the development of an efficient fertilizer marketing and sypply sytem;

b. using short term technical assistance from appropriate technical fields in cooperation with representatives from concerned ministries and institutions, prepare an action plan for the development of an efficient fertilizer marketing and suppl- system tailored to Zambia's conditions.

c. assign appropriate technical personnel to assist in the establishment of the system.

2. that a plan be developed with implimenting proposals for the production and distribution of agricultural grade limestone.

B. OTHER SUPPORTING RECOMMENTATIONS

1. that donor assistance be encouraged for the provision of additional permanent storage facilities with priority at the rural depot level and that this assistance be done in accordance with the above overall coordinated action plan, detailing size, nature of construction and location;

2. that the fertilizer distribution system be designed to move fertilizer more directly to final destination in units which will reduce transfers and handling losses. The details of such a system should be a part of the above action plan.

3. that one organization be specifically structured to manage the marketing and supply of fertilizers. This organization should be provided with enough autonomy and be held responsible for carrying out all the marketing functions, including sale to final user.

4. that the uniform pricing structure of fertilizer be replaced with a system of pricing whereby internal transfer prices for product moving from port to final sale will measure the value added at each stage, and the price to final user will reflect that value added. There should also be a price differential reflecting the storage costs, such that fertilizer would cost less for early purchase.

5. that the agency responsible for importing fertilizer take title in Zambia to place the burden of transport losses and delays on the transporters, providing incentive to efficiently move the product to destination on time.

6. that the National Lima Fertilizer Program should be supported as a priority for intensified educational effort to increase small farmer Knowledge about fertilizer use and improve crop management techniques.

7. that a training program be initiated for fertilizer market managers at all levels. This would include teaching depot managers appropriate storage techniques and improved accountability procedures. The training and development of these individuals is a task of sizeabl magnitude requiring adequate planning and funding.

III. FERTILIZER'S ROLE IN THE DEVELOPMENT OF THE AGRICULTURAL SECTOR

Analysis of Zambia's fertilizer market system must be carried out in the context of the resources available and the economic, social and political environment in which the system operates as well as the role fertilizer plays in the development of the nation's agriculture.

Zambia has the land area, climate, soil and water resources for major agricultural development. Only about one sixth of the estimated 60 million hectares of arable land is currently being farmed. While rainfall limits crop production in some regions, water resources from lakes, streams and underground sources provide the potential for irrigated production. Zambia's soils, though inherently unfertile and acidic, respond well to applications of fertilizer and lime to produce good yields of the major food crops. Substantial deposits of lime and phosphate remain mostly undeveloped for fertilizer production.

Agricultural production is most developed along the line of rail from Livingstone to the Copperbelt, but is expanding into the regions commonly thought of as subsistance farming areas. Agricultural production is characterized by contrasts. A small group of approximately 400 highly developed large scale commercial farms contrasts with about 600,000 small holder subsistance farms. The commercial farmers use many of the latest production techniques, including the application of fertilizer. Most of their crop production is marketed. The subsistence farmer by contrast depends upon the hoe for tillage, uses unimproved seed and seldom uses fertilizer for the crops he produces. The subsistence farmer consumes most of what he produces.

A small but growing group of small scale farmers are using improved seeds and oxen or tractors to produce the same range of crops as commercial farmers, plus cotton. This group of farmers uses fertilizer for crop production and is especially subject to the risks associated with dependence upon the performance of the fertilizer marketing system.

The main crops grown in Zambia are maize (the chief staple food crop), groundnuts, cassava, sunflowers, millet, sorghum, beans, tobacco and cotton; livestock and poultry production are also important. Many of these crops are dependent upon fertilizer application for good yields, especially the new, high yielding maize varieties.

Zambia's economy has faced serious problems in recent years due in part to a sharp decline in copper prices. There has been a need to diversify the economy to become less dependent upon copper production and export. As a result the government has shifted priority toward the development of the agricultural sector with the ambitious goal of food self-sufficiency. A number of policies and incentives have been instituted to encourage an intensification of food production. These include substantial increases in controlled crop prices and until recently the heavy subsidization of fertilizer prices.

The Zambian Government has recently taken belt tightening measures to bolster the sagging economy. Among these is the devaluation of the Kwacha and the reduction of subsidies including fertilizer subsidies. Both measures substantialy increase the cost of supplying fertilizer to the farmer, since both fertilizer raw materials and finished products are largely imported. Cost in foreign exchange earnings for fertilizer imports has also increased. Any fertilizer losses sustained due to

inefficiencies in the marketing system and lack of appropriate application techniques become increasingly burdensome to the economy. Ultimately the price tag of food self-sufficiency has increased.

Nonetheless, Zambia's soils need fertilizer and lime along with sound management practices to provide good yields over a sustained period of time. To reach the goal of food self-sufficiency, fertilizers and improved technical skills must be available to all categories of farmers. This increased importance of fertilizer emphasizes the need for an improved fertilizer marketing and distribution system supporting an integrated approach to agricultural development.

IV. FERTILIZER CONSUMPTION

Current fertilizer consumption levels, historical trends in consumption, costs and the structure of fertilizer use (how, where, by whom, for what purpose) are not only a reflection of the performance of the fertilizer market system, but also influence its performance. Evaluation of this performance combined with expectations of what future consumption patterns will be are important to planning for an efficient fertilizer supply system and the supporting policies essential to its improved performance.

Fertilizer consumption has increased substantialy in accordance with its increased role in agricultural production. From 1975-1982 the volume of fertilizer sales increased (Table 1) from 133,695 metric tons to 211,864 metric tons (most of which was imported). This is a 58% increase over the last 7 years, an average annual increase of 8%. Of the most commonly used fertilizers, Compound "K" fertilizer has increased by 300%, Compound "X" by 184%, Compound "D" by 143% and urea by 248% during the same period. Table 2 shows that the increase in consumption of nitrogen and phosphate has doubled from 1971-1982. Potash's somewhat irregular consumption pattern has remained relatively constant.

Using figures supplied by the World Bank it is estimated that the economic cost of fertilizer delivered to the rural areas has increased 58%, since 1975. This increase combined with the increase in volume used has raised the total price tag of fertilizer delivered to the farmer from approximately 44 million Kwacha to 98 million Kwacha, an increase of 125% (See Table 3). This represented a foreign exchange

TABLE 1 - FERTILIZER SALES TO PROVINCES BY NAMBOARD

TYPE	1975	1976	1977	1978	1979	1980	1981	1982
	MT							
A	115	-	303	476	151	58	4	18
C	8,389	3,228	539	5,988	4,298	5,429	6,079	4,164
V	3,732	563	4,117	3,282	1,509	1,509	2,308	1,426
R	17,483	21,909	23,472	16,709	26,448	38,977	41,819	31,762
X	20,360	22,161	30,121	20,166	19,952	35,534	29,853	37,930
D	24,705	30,411	31,673	30,184	28,005	28,921	35,924	53,366
Urea	32,043	46,780	47,713	27,536	42,402	57,171	64,793	58,764
AS	6,412	725	2,197	2,030	870	1,294	1,898	2,303
AN	17,793	17,284	25,339	20,292	17,842	24,317	26,458	21,142
SN	708	708	254	563	156	167	297	30
MOP	11	38	134	87	140	141	105	44
SOP	316	1	35	62	62	78	185	64
SSP	1,086	751	130	308	137	517	236	99
TSP	386	1,325	1,480	1,588	1,581	2,051	1,919	662
Others	156	4,900	-	471	2,035	197	16	50
TOTAL =	133,695	150,774	167,507	130,077	145,368	196,361	211,940	211,864

SOURCE: Annual Agricultural Statistical Bulletin, 1981

Central Statistical Office, P.O. Box 31908, Lusaka 11182 And NAMB 1983

TABLE 2 Consumption of N, P_2O_5, and K_2O in Zambia, 1971 - 82

Year	N	P_2O_5	K_2O	Total
	(mt)			
1971	32,800	12,900	7,600	53,300
1972	25,000	11,900	4,900	41,800
1973	24,000	11,600	7,900	43,500
1974	35,900	14,700	11,400	62,000
1975	33,700	14,600	5,200	53,500
1976	39,700	14,100	4,600	58,400
1977	46,200	15,600	5,700	67,500
1978	31,000	14,000	5,600	50,600
1979	38,200	14,600	4,900	57,700
1980	53,000	19,500	6,100	78,600
1981	57,600	20,900	6,700	85,200
1982	68,700	23,700	7,000	99,400

Source: For 1971 through 1975, FAO data on TVA files.
For 1976 through 1982, "Fertilizer Study," by Asthana and Di-Biase, December 20, 1982.

ZAMBIA

BLE 3

Export and Import Substitution Strategy Study

Average Price Structure of Imported Fertilizer 1/
(K/Tonne)

Year	Landed Cost cif (Lusaka)	NAMB Economic Handling Costs 1/	Total Economic Costs	NAMB Selling Price	Fertilizer Subsidy Producer	SCF* for Producer Price
1975	268	29	297	79	218	3.76
1976	250	40	290	132	158	2.20
1977	199	38	237	131	106	1.81
1978	272	49	321	168	153	1.91
1979	288	34	322	231	91	1.40
1980	337	56	393	183	210	2.15
1981	399	65	464	234	230	1.98
1982	413	58	471	244	227	1.93
1983 (est)	407	58	465	299	166	1.56

*SCF is a conversion factor used to relate the NAMBOARD/selling price to the economic cost.

1/ NAMB's financial handling costs were discounted by an SCF 0.80

2/ This is an SCF for fertilizer prices to producer. World Bank, 1983

cost to Zambia of 74 million kwacha in 1982. These costs are an important investment in Zambia's agricultural production. Any fertilizer losses caused by inefficiencies in the marketing system or from farmers using inappropriate application techniques or from the application of the wrong type of fertilizer mean important losses of foreign exchange as well as losses to the economy as a whole.

Many factors will influence future fertilizer consumption in Zambia among which are fertilizer price (including subsidy levels), crop price, availability of credit, crop response to fertilizer application, technical knowledge and management levels of farmers, Zambia's economic situation etc. Lacking adequate data concerning these factors the study team has used historical trends as a basis for long range projections to 1990 (Table 4). By 1990 over 100,000 tons of compound "P", 144,000 tons of urea and almost 50,000 tons of ammonium nitrate will be required (Table 5). A graph (Figure 1) illustrates the projected needs for nitrogen, phosphate and potash from 1983 to 1990. As rough as these projections are, they provide some idea of the magnitude of the problem. The supply and delivery of 430,000 metric tons of fertilizer will require an improved and efficient marketing system. The costs of investing in this much fertilizer will require an improved crop production capacity as well. If research and educational efforts have a greater impact than in the past, the fertilizer tonnage required could be substantially reduced. Likewise, a more efficient marketing system could mean substantial reduction in the fertilizer consumption requirements. As will be mentioned in the chapter on products, a shift to higher analysis fertilizers would substantialy alter these requirements.

Despite the rapid increases in fertilizer consumption, Zambia

TABLE 4 DEMAND PROJECTIONS FOR N, P_2O_5, AND K_2O FOR ZAMBIA, 1983-90

Year	N	P_2O_5	K_2O
	(mt)		
1983	73,900	25,400	7,100
1984	79,400	27,100	7,500
1985	85,300	29,000	8,000
1986	91,700	31,100	8,500
1987	98,600	33,200	9,000
1988	106,200	35,600	9,500
1989	114,000	38,100	10,100
1990	122,500	40,700	10,700
Growth rate	7.5%	7.0%	6.0%

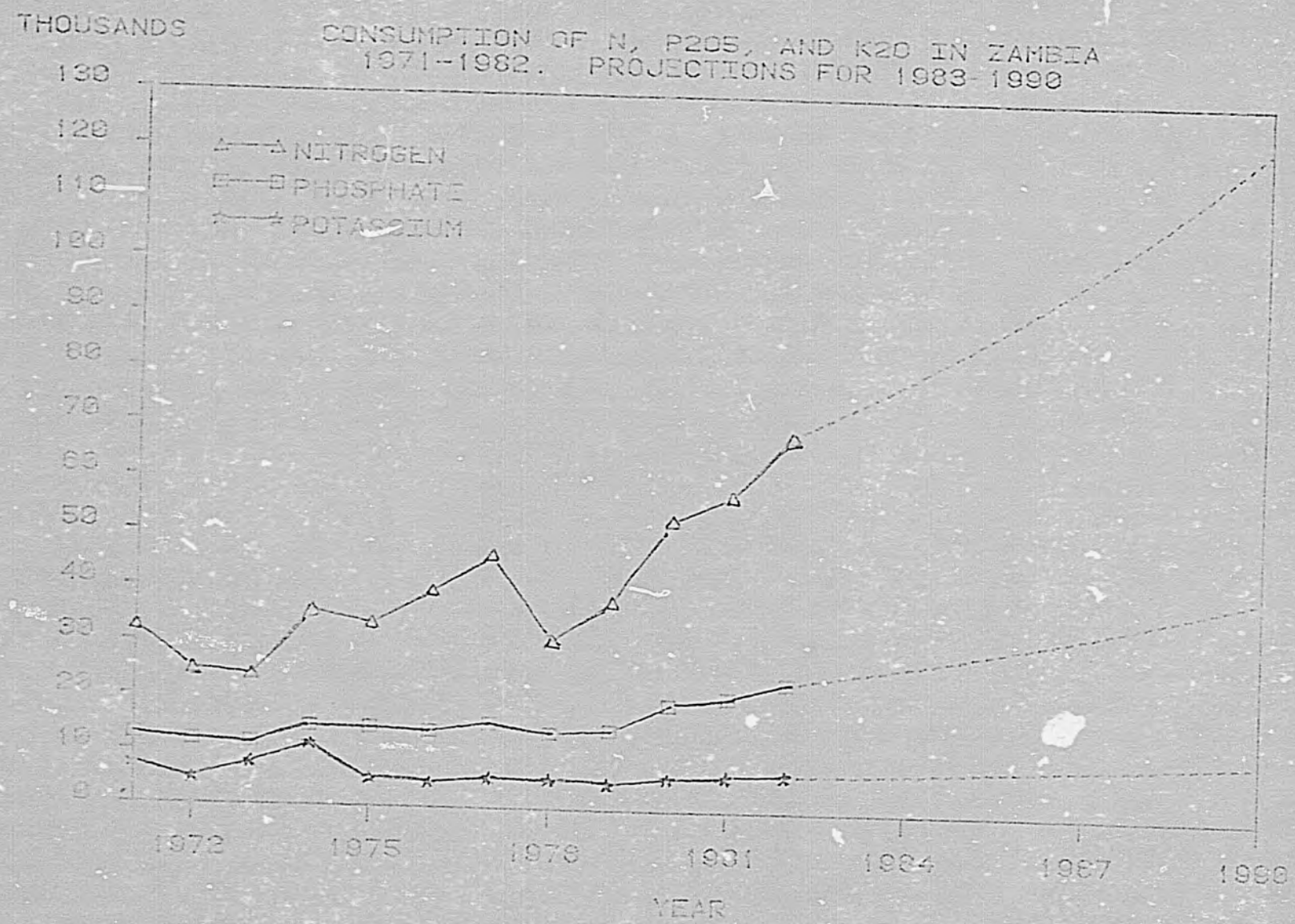
Source: IFDC, 1983

TABLE 5 DEMAND PROJECTIONS FOR MAJOR FERTILIZER PRODUCTS, ZAMBIA 1983, 1986, and 1990[a]

Product	1983	1986	1990
	(mt)		
Mixtures			
C (6-18-12)	7,100	8,600	11,300
V (4-18-15)	1,400	1,700	2,300
R (20-20-0)	57,200	74,600	101,800
X (20-10-5)	38,100	46,700	61,000
D (10-20-10)	38,100	42,000	50,900
Straights			
Urea	86,800	107,600	144,400
Ammonium sulfate	2,400	3,000	4,000
Ammonium nitrate	29,700	36,900	49,500
Triple superphosphate	2,200	2,700	3,500
Potassium chloride	200	400	600
Potassium sulfate	400	800	1,000

a. In addition to this, small amounts of mixture A, SSP, SN may be consumed. Contents on a nutrient basis do not add exactly to totals on a nutrient basis presented in Table 2 due to rounding.

FIGURE 1



SOURCE: IFDC, 1983

still ranks in the low-medium category in application rate per hectare of fertilizer nutrients applied to arable land and permanent pasture (Table 6 and Figure 2). This figure is likely a reflection of the size of arable lands relative to the number of producers using fertilizer.

In 1981, Zambia ranked 6th among African countries in the consumption of nitrogen fertilizer at 57,000 metric tons, just half of that consumed by Zimbabwe, her neighbor (Figure 3). Urea and ammonium nitrate are the main sources of nitrogen which together account for 40% of fertilizer sales. Urea, which represents approximately 30% of fertilizer sales, is imported. As will be discussed later, the increasing popularity of nitrogen fertilizers among Zambian farmers has both cost and agronomic implications.

Most of the fertilizer consumed in Zambia is sold in Southern, Central and Eastern Province. These provinces account for approximately 42, 25 and 13 per cent respectively for a total of 80% of fertilizer sales. They also represent 80% of the hectarage under production to maize. More recently Northern Province has substantially increased its fertilizer intake in response to an increased maize production.

It is estimated that maize, Zambia's main staple food, accounts for approximately 75% of all fertilizer used. (DiBiaze, pg.67)* This would help to explain why the main maize growing areas of Zambia are also large consumers of fertilizer. Some are concerned that maize production increases do not reflect the enormous increases in

* Footnote: "Fertilizer Study" by Asthana and DiBiaze, Food Security Project, Ministry of Agriculture and Water Development, 1982.

Table 6. Africa: Total Fertilizer Use Per Hectare of Arable Land and Permanent Crops, 1970-80

Region	1970	1975	1979	1980
	(kg/ha)			
Algeria	16.5	23.0	23.1	32.0
Angola	6.3	2.2	3.9	4.8
Benin	1.9	1.0	1.6	1.7
Botswana	4.0	4.7	0.8	1.0
Burundi	0.5	0.8	0.7	0.8
Cameroon	2.8	1.7	4.8	5.1
Cape Verde	-	4.5	2.2	0.1
Central African Republic	0.4	0.3	0.1	0.5
Chad	0.3	1.3	NA	.3
Congo	11.4	3.5	0.1	0.8
Djibouti	NA	NA	1,844.0	1,900.0
Egypt	131.2	175.1	212.1	232.4
Eq. Guinea	8.4	0.4	0.4	0.4
Ethiopia	0.4	2.4	6.0	4.0
Gabon	-	2.6	1.1	0.2
Gambia	1.3	2.9	12.1	12.2
Ghana	1.3	10.3	6.7	4.3
Guinea	0.5	0.5	1.4	0.2
Guinea Bissau	NA	NA	0.7	0.7
Ivory Coast	2.4	4.7	13.5	13.7
Kenya	28.6	25.2	16.9	26.2
Lesotho	1.0	4.2	13.8	15.4
Liberia	6.3	5.8	11.3	9.2
Libya	5.0	14.1	23.5	37.4
Madagascar	5.0	2.1	2.5	2.9
Malawi	5.2	4.9	9.1	14.1
Mali	0.5	0.2	3.3	6.0
Mauritania	0.3	1.1	10.8	10.8
Mauritius	209.5	227.8	252.0	248.0
Morocco	11.6	21.4	28.9	33.5
Mozambique	2.2	1.9	5.7	9.0
Niger	-	0.1	0.7	0.8
Nigeria	0.3	2.2	3.3	5.7
Reunion	203.2	154.1	287.8	205.0
Rwanda	0.3	0.9	0.3	0.1
Senegal	3.6	18.2	5.6	3.6
Sierra Leone	0.6	1.2	1.5	1.0
Somalia	2.5	3.5	1.9	2.3
South Africa	38.6	52.1	64.3	77.9
Sudan	5.2	12.7	4.1	6.5
Swaziland	39.6	56.0	39.0	71.1
Tanzania	2.9	4.9	5.8	6.9
Togo	0.2	1.0	2.3	3.0
Tunisia	7.9	11.2	12.1	13.5
Uganda	1.4	1.0	NA	0.1
Upper Volta	0.1	0.1	4.3	4.0
Zaire	0.6	0.7	1.2	1.3
Zambia	7.3	15.6	11.7	15.7
Zimbabwe	45.2	63.3	48.5	65.5
AFRICA	7.8	11.5	15.6	18.4

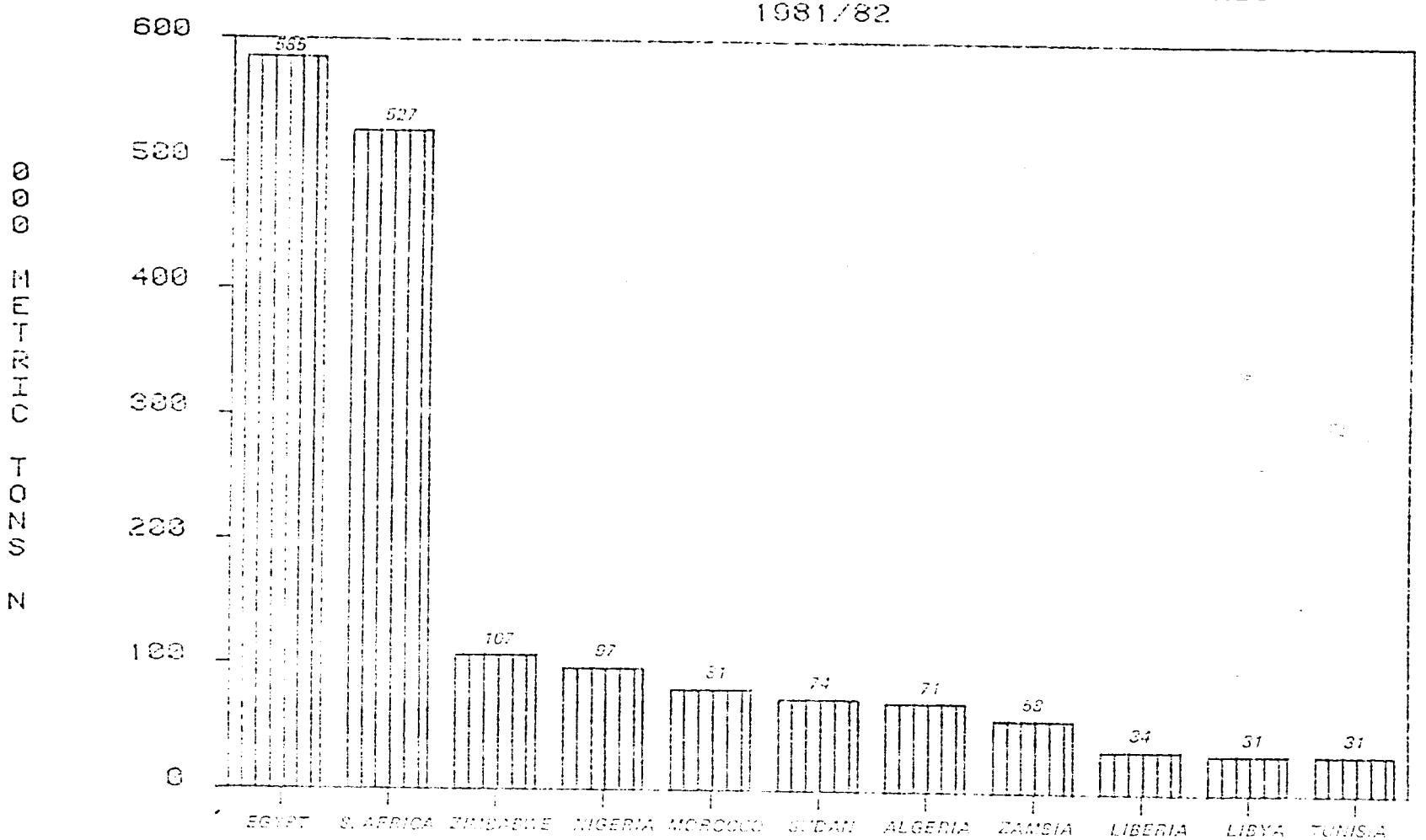
Source: Latest FAO yearbooks.

Source: 1981 FAO Fertilizer Yearbook.

Figure 2 Africa: Map of Fertilizer Use Per Hectare of Arable Land and Land in Permanent Crops, 1980.

Figure 3

AFRICA: LARGEST NITROGEN CONSUMING COUNTRIES
1981/82



SOURCE: FAO

fertilizer use. When one compares the nitrogen use to the production of cereals (including maize) Table 7 shows that while nitrogen consumption went up by 75.6% cereal production only increased by 11.8% One should be careful about such comparisons, since there are a multiplicity of factors upon which production depends, not the least of which are a variety of management factors. Also the study team observed that fertilizer is being used for pasture improvement by commercial farmers.

Substantial increases in future maize and other crop production depend on small farmers beginning to use adequate amounts of the appropriate fertilizers, applied with the right techniques at the right time. In order for this to happen, the fertilizer must be available when they need it. But, are small producers using fertilizer? What are they using it on? And is it having an impact on crop production?

The study team attempted to answer these questions in the limited time they had through visits to Southern, Central and Eastern Province. Cooperative marketing unions, provincial agriculture officers, researchers on the Agricultural Research Planning Teams,and individual farmers were contacted. It became apparent that the record keeping systems used by the cooperatives are inadequate to provide information about who is buying fertilizer and for what purpose. Southern Province Cooperative Union had record of all transactions made to rural depots, pointing to the fact that substantial fertilizer is moved by these depots which typically mostly service small scale farmers.

Two research studies conducted by the University of Illinois/GRZ ARPT team at Kabwe shed light on the availability of fertilizer and use practices of small scale producers. According to the findings, small

TABLE 7: COMPARISON OF NITROGEN SALES INCREASE TO CEREAL GRAIN INCREASE

(mt)

	1971	1981	% Change
NITROGEN	32,795	57,600	75.6
CEREAL GRAINS	1,000,000	1,118,000	11.8

Source: FAO 1981 Production Yearbook
and IFDC

scale farmers are getting a share of the fertilizer. Whether this is a fair share or not could not be determined. Information from this research also revealed common fertilizer application practices. For example, about 22% of the farmers apply the basal fertilizer at maize planting time (when it should be), while the majority wait until the maize is 16 to 30 centimetres high. Over half apply top dressing when the maize is 41 to 80 centimetres high. Application rates tend to be low relative to high yield recommendations and some fertilizer is applied on local maize. Small scale farmers were found to apply the same rates of basal and top dressing fertilizers in both light and heavy soils. These studies show that, while fertilizer is being used, the way it is often applied is wasteful of fertilizer and reduces the potential for appropriate crop yields.**

**See the following reports:

1. "Final Report of the Formal Survey in Traditional Recommendation Domain (Kabwe Rural Distric, Central Province)", Adaptive Research Planning Team,
June, 1983

2. "Are Small Scale Farmers Getting A Fair Share of Fertilizer ?", Alfred G. Harms, Farming Systems Economist, Adaptive Research Planning Team, Kabwe Regional Research Station, Zambia, July, 1983.

Through the efforts of the Provincial Farm Management Officer in Eastern Province, visits were made to two settlement schemes and a number of small farm units. The Chinjara Settlement Scheme in Northern Chipata provided the team excellent records and information which became the basis for the case study which follows:

CHINJARA SETTLEMENT SCHEME

AN EASTERN PROVINCE CASE STUDY OF FERTILIZER USE

Rural depots (retail outlets) in Eastern Province, like most in Zambia do not keep records by which to trace what use is made of fertilizer once the transaction is made. Depot managers are basically sales clerks who know little about the product which they handle, let alone any information about the farmers with whom they deal or the types and levels of crop production they have on their farms. Typically, these managers are in no position to advise on product use, nor can they provide accurate estimates about how much fertilizer is going to be used by their customers from one year to the next. Thus, information gathered from these sources will often be inaccurate, biasing the nation's estimated fertilizer requirements. Accurate records on fertilizer use are indeed hard to find.

The fertilizer market study team, however, found an exception to this in the North Chipata District of Eastern Province at the Chinjara Settlement Scheme. This settlement scheme is being transformed into a cooperative society. A rural cooperative depot is located in the settlement scheme area. Here records are kept for each farmer in the scheme on amounts and types of fertilizer used, types of crops upon which it is used, hectarages, yields and total sales. Information

provided by the Extension personnel involved in the project became the basis for answering questions on fertilizer use and response to fertilizer application in small farm production. The small sample size and special nature of the group must be considered in drawing conclusions from the study. However, the study team felt useful insight was gained from the information gathered.

For the sake of the study, the team found it appropriate to categorize the farmers on the scheme into three groups according to number of hectares cultivated. The farmers with less than 5 hectares make up the first category, those with 6 to 10 hectares make up the second category and lastly the farmers with more than 10 hectares make up the third category. The study attempts to determine which category utilizes more fertilizer and if there is a corresponding response in terms of yield to fertilizer level of use. The following are the team's observations and analysis taken from the data of three seasons, 1978/79, 1979/80 and 1980/81:

A. Out of an average membership of 42 small scale commercial farmers per year (Table 8), 27% fell in the first category of less than 5 hectares and account for an average of only 8% ofthe total fertilizer used in the scheme. The second category with 30% of the farmers accounts for 20% of the fertilizer used. The rest i.e. 72% of the fertilizer is used by farmers in the scheme with more than 10 hectares under cultivation.

B. The average fertilizer application per hectare by each category for the three years under review are shown in tables 9, 10 and 11. For the first category an application rate of 10 (50 Kg.) pockets per hectare was used, roughly 5 each of basal and top-dressing. The second group applied 12 per hectare and the third , 10 per hectare. These fall

FERTILIZER APPLICATION - CHINJARA SETTLEMENT SCHEME - TABLE 8

		1978/79	1979/80	1980/81
Total fertilizer used per year (bags)		3470	5202	7452
Fertilizer used by category of farmers per year	1	330.6	584.5	211
	2	817	1055	1320
	3	2322	3561	5922
Percentage of fertilizer used by category of farmers each year	1	10	11	3
	2	24	20	18
	3	66	69	79
Percentage of farmers in each category in a particular year	1	27	38	11
	2	30	22	30
	3	35	40	59
Average fertilizer application per Ha by category	1	9.2	11.5	10.1
	2	9.7	14.5	11.8
	3	9.2	10.3	10.8

Category: 1 = farmers within 0 - 5 Ha of maize

2 = farmers within 6 - 10 Ha of maize

3 = farmers within 10 Ha of maize

Fertilizer is in 50 Kh pockets

SOURCE: Chinjara Settlement Scheme - Eastern Province.

CHINJARA SETTLEMENT SCHEME - EASTERN PROVINCE - Table 9

(1978/79)

	0 - 5 Ha: n = 11			6 - 10: n = 12			Above 10 Ha: n = 14		
	Total	Average	Standard Deviation	Total	Average	Standard Deviation	Total	Average	Standard Deviation
Hectarage	36.3	3.3	1.0	84	7.0	1.4	252	18	9.6
Basal Dressing Fertilizer	171.6	15.6	8.5	403	33.6	8.1	1156	32.6	52.8
Top Dressing Fertilizer	159.5	14.5	8.3	414	34.5	8.0	1166	83.3	57.4
Production	1297	117.9	75.1	3238	269.8	144.4	8162	583	377
Sales	1032	93.8	37.7	3080	256.7	148.5	7651	546.5	376.9
Production per Hectare		33.9	15.9		38.4	15.3		31.9	17.2

The figures are on maize production

The fertilizer is in 50Kg pockets

The production and sales figures are in 90Kg standard bags

SOURCE: Chinjara Settlement Scheme, an Upcoming Cooperative Society in Eastern Province.

Table 10 - 1979/80

	0 - 5 Ha: n = 17			6 - 10 Ha: n = 10			Above 10 Ha: n = 18		
	Total	Average	Standard Deviation	Total	Average	Standard Deviation	Total	Average	Standard Deviation
Hectarage	51	3	1.37	73	7.3	1.3	345.6	19	5.5
Basal Dressing Fertilizer	287	16.9	11.9	525	52.5	29.4	1767.6	98	48
Top Dressing Fertilizer	297.5	17.5	12.7	530	53	31	1794.6	99.7	58
Production	1348	79.3	90.0	2585	258.5	142.2	13320	740	655
Sales	843	49.6	83.8	2416	241.6	143.8	12400	688.9	607
Production per hectare		23.6	17.7		32.1	22.2		38	18.8

The figures above are on maize production

The fertilizer is in 50Kg pockets

The production and sales figures are for 90Kg standard bags

SOURCE: Chinjara Settlement Scheme - An Upcoming Cooperative Society in Eastern Province.

Table 11 - 1980/81

	0 - 5 Ha: n = 5			6 - 10 Ha: n = 13			Above 10 Ha: n = 26		
	Total	Average	Standard Deviation	Total	Average	Standard Deviation	Total	Average	Standard Deviation
Hectarage	21	4.16	0.71	112	8.6	1.1	546	21	9.6
Basal Dressing Fertilizer	106	21.2	3.1	663	51	24	2959	113.8	52.9
Top Dressing Fertilizer	105	21	3.8	656.5	50.5	25.7	2963	113.96	58
Production	860	172	36.5	4823	371	163	21099	811.5	576
Sales	836	167.2	37.7	4562	350.9	170	20605	792.5	548.5
Production per hectare		42.6	12.1		42	18.9		35	20.1

The figures above areon maize production

The fertilizer is in 50Kg pockets

The production and sales figures are in 90Kg standard bags

SOURCE: Chinjara Settlement Scheme - An Upcoming Cooperative Society in Eastern Province

within the range of recommendations issued by the Central Research Station at Mt. Makulu for the low to medium management level of application. However, yields on the average did not correspond to the levels one would expect. The yield results per hectare on the average in all groups fall close to the 40 bags Mt. Makulu results show to be expected for "low management" applications.

C. Average yields hide the variations in management exhibited by the data. Table 12 shows the yield response of maize to fertilizer applied for the 1978/79 crop year to be in a range of 1.3 bags to 6.1 bags of maize per bag of fertilizer. Approximately 88.5% of the farmers had yield response below 5 bags of maize per bag of fertilizer, well below what it should have been. The years 1979/80 and 1980/81 show similar low level yield response to fertilizer application and a wide range of variation.

Table 12 - CHINJARA SETTLEMENT SCHEME
MAIZE YIELD PER BAG OF FERTILIZER APPLIED

Year	1978/79	1979/80	1980/81
Bags of Maize Produced per Farm	342.0	384	588
Bags of Fertilizer Applied per Farm	95	119	154
Yield per Bag of Fertilizer	3.6	3.2	3.8
Range in Yields per Bag of Fertilizer	1.3-6.1	0.8-6.5	0.8-6.3
Per cent of Farms with Yields below 5 Bags of Maize per Bag of Fertilizer Applied	88.5	91	76

D. Conclusions reached from the study are:

1. At least this small sample of farmers were using fertilizer at a low to medium level of application, based on Mt. Makulu research standards.
2. Management levels and other related factors play an important role in determining the level of yield response to fertilizer application. The information gathered can provide a basis for educational programs to improve management.
3. Such information as that being collected by the Extension worker at the Chinjara Settlement Scheme is valuable in helping to determine fertilizer needs for a given area. Such information, gathered on a national level could improve forecasted national needs.

V. FERTILIZER PROCUREMENT

Fertilizer procurement involves selecting fertilizers appropriate for Zambian farmers to use, determining how much of these fertilizers will be needed (demand forecasting) and from what source they will be supplied (locally manufactured vs. imported) and ordering the fertilizers for delivery to the distribution system. The study team examined each of these steps in the process to identify constraints which might contribute to inefficiencies in the system.

A. PRODUCT SELECTION

The types of fertilizers which will be selected in the procurement process are largely predetermined by research recommendations from the fertilizer research carried out at Mount Makulu. Details of the types of products being recommended and rates of application will be discussed in section IX, Agronomic Research and Recommendations. There are basically five compound fertilizers for basal application, with the most popular being compounds "D" (N-P-K of 10-20-10), "R" (20-20-0), and "X" (20-10-5). Two compounds contain boron (compounds "C" and "V") for use on tobacco. All compounds recommended for basal application contain 10% sulfur. Compound "R" appears to be gaining in popularity and is given as a blanket recommendation for Southern Province. Two straight nitrogen products, urea and ammonium nitrate are supplied for top dressing. Of the two, urea seems to be preferred. Even though recommended by research for some years, lime is not used to any extent.

Fertilizer products are all packaged in 50 Kg. (net) polypropylene woven, ultraviolet-resistant bags with a 4-ply polyethylene liner.

B. DEMAND FORECASTING

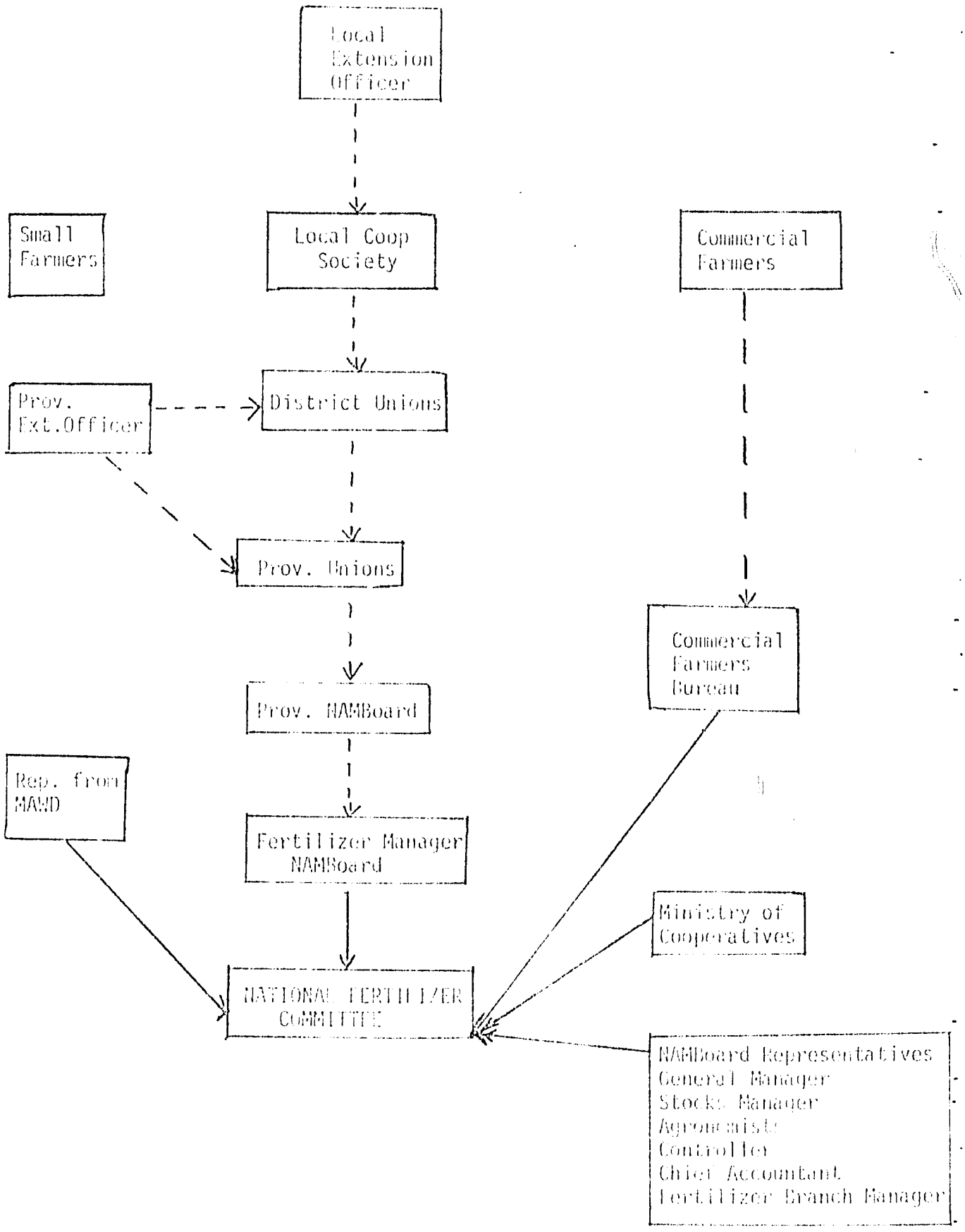
The process of determining how much of each type of fertilizer will be needed and where is important, since these decisions ultimately determine whether appropriate fertilizers will be available to farmers when they need them. This requires forward planning up to a year in advance of the types and volumes of imported and manufactured products. Figure 4 depicts the information flows and stages in this process.

The process of deciding how much fertilizer will be needed from all sources begins at the local cooperative society level. The local cooperative society employee and the local extension employee meet to determine the level of fertilizer sales and the amount of each type of fertilizer that will be demanded. This meeting occurs about 18 months before the fertilizer will be used. The local society employee generally does not have records on the production, yield and marketing figures for customers for prior seasons. The forecast is therefore based upon the best estimate of the extension officer. Although the officer has contact with small farmers, no direct input from small farmers enters the forecasting process.

The requests of each cooperative society are then submitted to the district unions for consolidation and evaluation. At the district level, the hired union officials and the district extension officer evaluate requests from societies within their district and pass the consolidated requests on to the provincial headquarters of the union. There a consolidated request for the province is prepared by the union officials and the provincial extension officer.

Province requests are consolidated and sent to the provincial NAMBOARD office. The extension officer, head union official and the

FIGURE 4 FLOW OF DEMAND FORECAST INFORMATION AMONG INSTITUTIONS PARTICIPATING IN FERTILIZER PRODUCT SELECTION AND VOLUME DETERMINATION



----------> Indicates participation in forecast request

. . . . . > Indicates participation in national fertilizer committee

provincial NAMBOARD manager then meet and agree upon the volumes and types to be brought into the province. This request is then submitted to the FIPS Manager at NAMBOARD headquarters in Lusaka.

The FIPS Manager and selected staff evaluate the requests for both the types and volumes of fertilizer requested. If questions arise about types or quantities of fertilizer, the provincial NAMBOARD officials are asked to justify the request. The justification is then reviewed by the FIPS Manager and staff. At this point requests may be rejected either on the basis that excess quantity or inappropriate products have been ordered. Or the justification given at the provincial level may be accepted.

Once all requests have been evaluated and corrected, they are consolidated and submitted to the National Fertilizer Committee for action. The National Fertilizer Committee may either accept or reject the requested quantities and types of fertilizer submitted. Generally, the requests are accepted with minor alterations. The reason the committee would make changes must usually be justified and a vote is frequently taken.

The study team found that the process of product selection and forecasting demand is constrained as follows:

1. The length of time required between the beginning of the forecast and the need for the fertilizer was 18 months, a very long range forecast.
2. The general lack of solid data at the sales center level represents a problem in putting together an accurate forecast which is geared to customer needs.
3. There is no procedure for updating the forecast as the time for tendering fertilizer approaches.

Serious problems result from the development of forecasts 16-18 months in advance of the anticipated use of the product. Farmers are generally not in a position at this point to give an indication of their upcoming fertilizer needs. They have not yet marketed the growing crop and do not know what price will be charged for fertilizer. Nor do they at this point have a good indication what price they will receive for the crop they will be selling two years hence. As a consequence, the estimate must be made on the basis of the best guess of the depot manager and the local extension personnel.

Alternatives to remove this constraint would include shortening the time required to complete the forecast procedure and the time required to tender and receive the physical product. The forecast process should be analyzed for means of speeding up the development of forecast information so that at least the crop has been harvested before the forecast goes. It would also be helpful if commodity and fertilizer prices were announced prior to this forecast.

The second constraint stems from a lack of adequate historical fertilizer sales, maize marketings and maize production data to use in determining future needs. The analysis of past purchasing behavior by farmers in various size categories is not now being used to develop forecasts in most cooperative societies. The team found that historical data on hectarage, production, yield and maize marketed was being kept by at least one local cooperative society in Eastern Province. This data allows a much more accurate forecast of future fertilizer needs of cooperative society members.

The rapid generalization of this procedure might be difficult but at a minimum, the local depot manager should determine the purchase of fertilizer, the marketing of maize and perhaps the hectarage of each

member of his society. The ultimate goal would be to generate sufficient knowledge of the society members' operations to generate an accurate forecast at the local level.

The third constraint in the forecast information system is the lack of a means of updating the forecast as the time for tendering approaches. The team observed that only one forecast was made and no attempt was made to update that forecast at the grass roots level after it was passed to the district cooperative union.

Alternatives should be explored to get revised estimates throughout the maize growing and marketing period up to the time that the product is tendered for imported finished product and raw materials. This would perhaps put stress on the current forecasting structure. That structure now requires that detailed review of requests be made at many levels in the distribution system and the process involves many organizations. An option would be to carry out the forecasting process as in the past, but allow later estimates to be made and the information moved more directly to those who will be making tendering decisions. Those tendering would then be able to make adjustments before the tender is actually made. Moreover, the up-to-date contact between NAMBOARD and the local cooperative societies would provide a useful mutual exchange of information about current conditions at both the export/import and farm levels.

C. PRODUCT PROCUREMENT - INFORMATION FLOWS

The process of procurement for fertilizer begins once the demand forecast has been completed. The procurement information flows are complicated and involve a large number of agencies and institutions. The processes are diagrammed in Figure 5 and are numbered according to the sequence of steps to be taken. (1) A request for bids is issued to

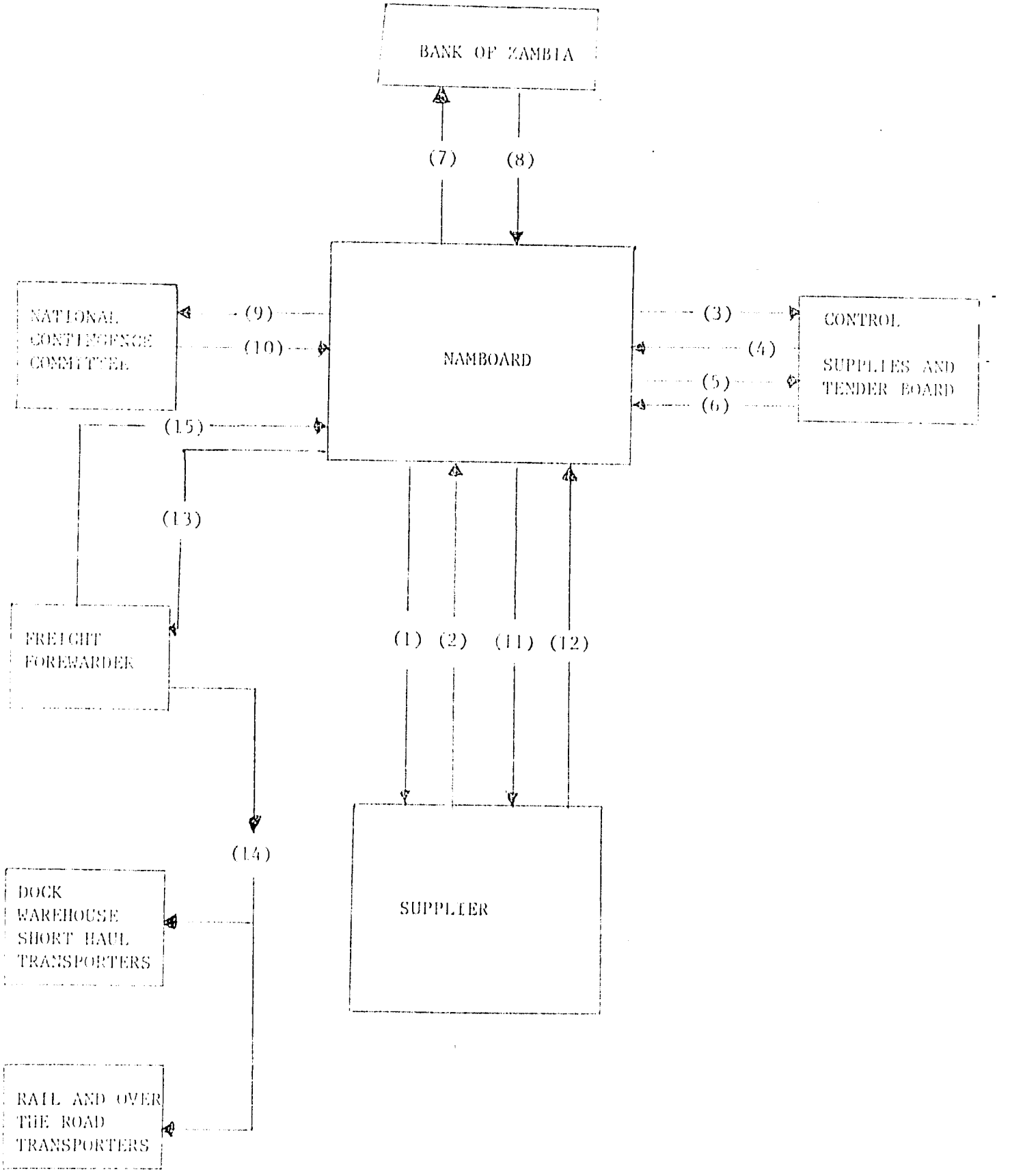


FIGURE 5

INFORMATION FLOWS IN THE IMPORT [illegible] UREMENT O[illegible] [illegible]LIZERS

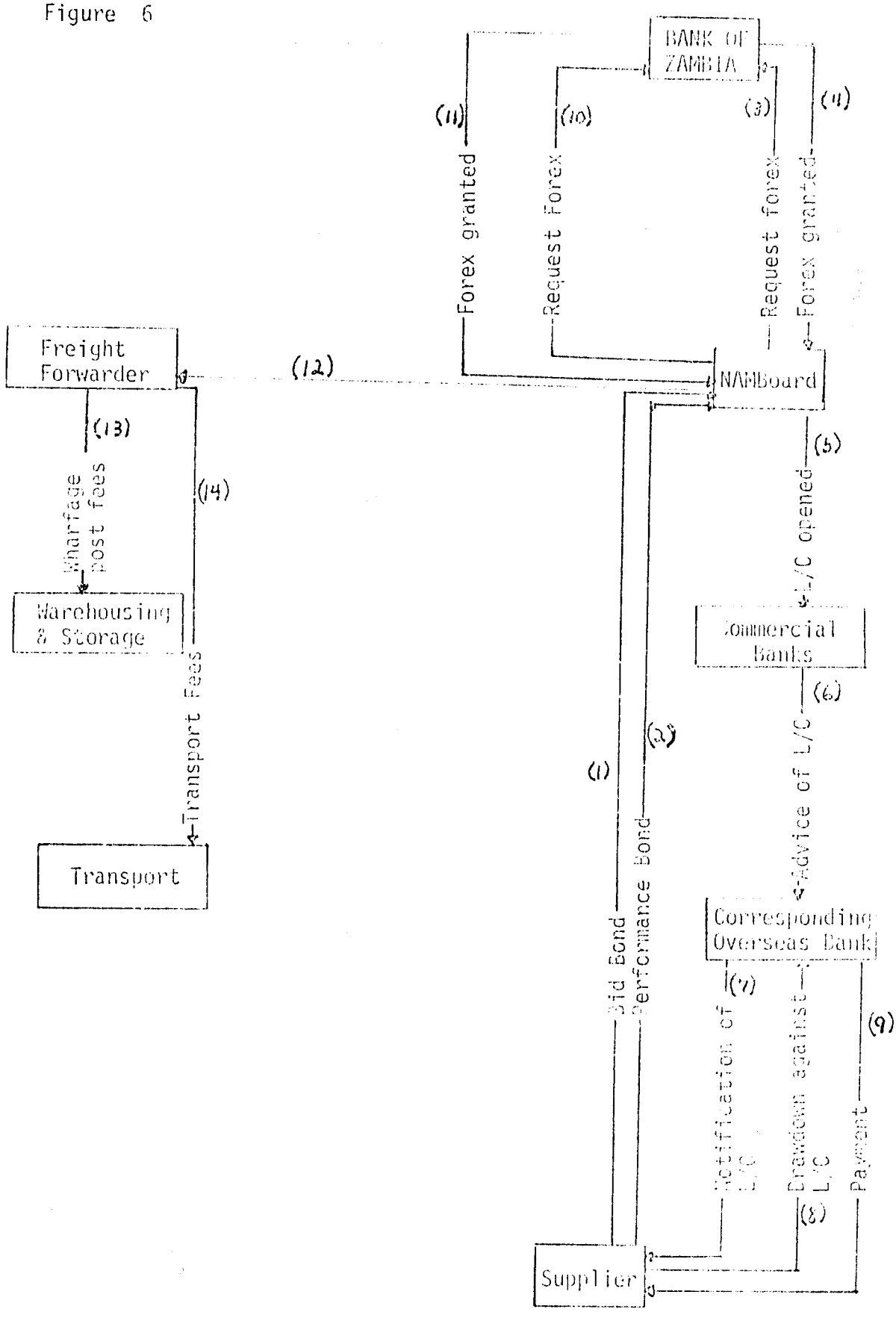
foreign suppliers. (2) These are generally returned as sealed bids to NAMBOARD denominated in either U.S. dollars or British pounds sterling or German Deutch Marks. These are valid for a period of two months. (3) NAMBOARD then opens the bids at an open meeting with the Central Supplies and Tender Board. (4) NAMBOARD evaluates these open bids and ranks them in accordance with their price and terms. (5) The ranked bids are resubmitted to the Central Supplies and Tender Board for approval, which may override the NAMBOARD ranking if it chooses, or it may approve and (6) return the bids to NAMBOARD. (7) Upon receiving bid approval, NAMBOARD applies to the Bank of Zambia for foreign exchange authorization for the tender. This may require months to be executed. When authorization is granted, NAMBOARD and the Central Supply and Tender Board are (8) notified. Whereupon, NAMBOARD contacts the National Contingency and Planning Committee for consideration. This committee meets once a month. (10) The Committee then responds to NAMBOARD with a designated POE for the fertilizer and orders as to how much should be shipped by rail and by truck. (11) The order is then placed with the supplier. (12) NAMBOARD is notified by the supplier when shipment has been made from the exporting country with expected time of arrival at port of entry. NAMBOARD (13) then notifies a freight forwarder that the shipment is on the high seas and gives the forwarder the estimated time of arrival. (14) The forwarder arranges for receipt of the shipment with the dock and port warehouses. Arrangements for short-haul transportation to the port warehouse are also made. The forwarder then arranges (15) for the transport to Zambia with rail or truck transport and notifies NAMBOARD of the shipping arrangements, giving the estimated time of arrival.

D. PRODUCT PROCUREMENT - FINANCIAL FLOWS

The financial flow for imported fertilizers is diagrammed in Figure 6. The financial flow begins at the time suppliers submit their bids in response to the invitation for bids (IFB) for fertilizer (arrow 1). The bid bond is typically 1% of the bid price. Unsuccessful bidders have their bid bonds released within 20 days after the offer expiration date. Successful suppliers provide NAMBOARD with a performance bond of 10% of the aggregate purchase price within 10 days after notification of an award (arrow 2). This is normally done by increasing the bid bond from 1% to 10%. Step 3 in the financial flow is NAMBOARD's request to the Bank of Zambia (BOZ) for foreign exchange equivalent to the aggregate costs for the total tonnage of fertilizer awarded. Next (arrow 4), the BOZ grants the foreign exchange enabling NAMBOARD to open a letter of credit in favor of each supplier with a commercial bank in Zambia. The commercial bank in Zambia advises their overseas corresponding bank that NAMBOARD has opened a letter of credit (arrow 6) and the overseas bank further notifies the supplier (arrow 7). After shipment of the product, the supplier submits his documentation for payment to the bank (arrow 8) and, if the documents are in order, the bank makes payment (arrow 9). This completes the financial flow as it relates to the suppliers.

NAMBOARD must now make financial arrangements with their freight forwarders to enable the fertilizer to clear the discharge ports and be transferred to Zambia. For material entering through Beira and Dar-es-Salaam, these costs can be paid in Kwacha. For shipments through East London, port and overland freight costs to Livingstone must be paid in foreign exchange. Thus, NAMBOARD must again request

Figure 6


BANK OF ZAMBIA
(11)
Forex granted
(10)
Request Forex
(3)
Request forex
(4)
Forex granted
Freight Forwarder
(12)
NAMBoard
(13)
Wharfage post fees
(14)
Warehousing & Storage
Transport Fees
Transport
(5)
L/C opened
Commercial Banks
(6)
Advice of L/C
(1)
(2)
Bid Bond
Performance Bond
Corresponding Overseas Bank
(7)
Notification of L/C
Drawdown against L/C
(8)
(9)
Payment
Supplier

(arrow 10) and be granted (arrow 11) foreign exchange from BOZ, before any fertilizer can move onward from East London. The next step, involving any of the coastall ports of discharge, is for NAMBOARD to consumate the financial arrangements with the appropriate freight forwarder (arrow 12) so that the forwarder can arrange payment for the port costs (arrow 13) and the transport fees to Zambia (arrow 14).

E. CONSTRAINTS IN INFORMATION AND FINANCIAL FLOWS

At best, this procurement process requires several months for completion. The study team noted several constraints:

1. The availability of foreign exchange for purchase of imported fertilizer is limited and the authorization comes very late in the cycle.
2. Meetings of the National Contingency Board are usually a month apart.
3. Transport at the port is not always available when needed.
4. There is no effective monitoring of the freight forwarders activities.
5. The many steps in the information flow system constrain the timely importation and distribution of fertilizer.

The team discovered a serious problem of the availability of foreign exchange for the timely purchase of fertilizer. Delays in granting foreign exchange for procurement of fertilizer prolonge the period between the awarding of bids and the shipping of product, because shippers will not ship fertilizer until they are in receipt of operable letters of credit. Delays in granting foreign exchange for movement from the port to Zambia further exacerbate the delays in the arrival of fertilizer at the rural depot.

Because fertilizer deliveries must conform to the biological crop production cycle for timely fertilizer application, even short delays in procurement are unacceptable and costly. Such delays mean that fertilizer will not be affective in increasing food production. In fact, the necessity of storing fertilizer through to the next season will result in sizeable shrinkage losses as well as increased financial costs for holding on to the product.

The root of the problem seems to be the scarcity of foreign exchange. In a meeting the team had at the Bank of Zambia, BOZ officials noted that the large request for forex in one lump was a major problem when forex was coming available in only smaller amounts. It was stated that the chances would be improved if requests were submitted more frequently than once per year and for smaller amounts.

In subsequent visits with NAMBOARD officials, they countered that they understood that the BOZ required the forex submission for fertilizer procurement at one time. Furthermore, the team found that the current years request was found to have been delayed even though it had been submitted in small increments.

It must be recognized that foreign exchange for inputs to agricultural production cannot be metered in the same continuous small amounts that would be acceptable for inputs in other manufacturing and non-biological production processes. The biological nature of agricultural production dictates that the inputs be available at the critical time for use in the total amounts required for the production process.

The team considers the delays in allocation of foreign exchange for fertilizer procurement to be a major cause for the untimely arrival of fertilizer at the rural depots, i.e. after planting time when

fertilizer should have been applied. To provide for the timely arrival of fertilizer at the rural depots may require foreign exchange allocation well in advance with an agreed upon timetable for releasing the funds.

Another way to help ease the foreign exchange problem is to specify in the IFB that suppliers bid on a CIF to Zambia entry point basis, eg. Livingstone. This way freight would be prepaid by the supplier and fertilizer could move to Zambia on a through bill of lading. This would especially expedite movement of fertilizer from the port at East London.

The need for foreign exchange may decline as more fertilizers are manufactured at NCZ. However, the projected growth in fertilizer demand will make the timely allocation of foreign exchange a continuing challenge.

A second constraint observed is the procedure for going through the National Contingency Planning Committee. The committee meets monthly. This could delay fertilizer order placement for up to 30 days.

The prompt availability of rail transport at the dock and port warehouse facilities is another constraint. The clearing agent sometimes experiences difficulty arranging for rail wagons at the port. Alternatives for removal of this constraint were not addressed in this study. A detailed evaluation of the railroads' capacity to move fertilizer is needed.

A fourth constraint observed is the inability of NAMBOARD to adequately monitor the activity of the freight forewarder. There is a bottleneck for goods arriving from East London to the Southern Province. Loss of consignment documents travelling with the rail wagon

into Livingstone has been a continuing problem. Rail cars without consignment documents are sided until ownership can be established and customs can be cleared. This problem and others associated with correct handling of product at the port needs to be investigated further.

Two alternatives could alleviate this situation: (1)tender shipments CIF Livingstone or other point in Zambia or (2) have increased participation by NAMBOARD agents at the ports.

The complexity of the system for procurement of fertilizer is in itself a constraint. Prompt action by NAMBOARD is inhibited by the large number of clearance meetings and authorizations that must be executed before the order is placed. This time consuming process prevents rapid entry into the international fertilizer markets and could result in fertilizer purchased at a higher price than would be necessary under a more streamlined system. These delays are unacceptable when they result in the product arriving after it should have been applied.

The primary alternative considered by the team for eliminating this constraint is the unification of most procurement decisions into an organization like NAMBOARD. The total authority to purchase fertilizer would not necessarily have to be vested in this organization. However, authority to act unilaterally within reasonable guidelines would significantly speed up the process and contribute to a smoother, less costly distribution system.

VI. FERTILIZER PRODUCTION

Nitrogen Chemicals of Zambia, Ltd.(NCZ) began commercial scale production of compound fertilizers in April, 1982. Capable of producing all of the fertilizer compounds used in Zambia (A, C, V, D, R, and X), NCZ is focusing production on compounds R, X, C, and D, which represent the major segment of the country's compound fertilizer requirements. They also represent the products containing the lowest proportion of imported components. The main raw materials used in the production of these compounds are ammonium nitrate (AN), ammonia, sulfuric acid, ammonium sulfate (AS) and compounds of phosphorus and potassium. Of these, AN, AS, sulfuric acid and ammonia are available from NCZ's internal producution. The phosphatic products (single super phosphate, triple super phosphate and diammonium phosphate) and the potassium compounds (potassium sulfate and potassium chloride), NCZ must import. (A detailed breakdown of recently imported raw materials is given in Table 13.) Prior to operating on a commercial level, NCZ conducted production runs on a pilot plant scale for each fertilizer grade that might be requested by NAMBOARD. Between the commencement of commercial operations and 31 March, 1983, NCZ has produced 56,200 M.T. of compound fertilizers, all of which NAMBOARD has purchased. (Table 14 shows NCZ production and Table 15 gives NAMBOARD's purchases). Current production is devoted entirely to Compound "X" (N-P-K-S of 20-20-0-10). Operating at the present level of approximately 50%-60% of the nameplate capacity of 140,000 M.T. annually, NCZ could produce through the end of September, 1983 approximately 14,000 M.T. of additional Compound "X".

However, NCZ is experiencing a severe shortage of bags for

packing the final product. Consequently, the 19,700 M.T. of Compound "X" produced in the period April to June, 1983 is now in storage awaiting bagging. NCZ's storage capacity for finished product is limited to 3 months production. As this capacity is essentially filled, lack of bulk storage space alone will prevent additional production until bagging operations resume. Another problem is that some of the stored Compound "X" has hardened and must be crushed and recycled through the production line.

NCZ has on order 600,000 bags from South Africa which is sufficient to bag the Compound "X" now in stock. Of these, 60,000 were received on July 13, 1983, another 40,000 are in transit, and the remainder are to be shipped at a rate of 100,000 per week. Additionally, 500,000 bags are being imported from West Germany. Thus NCZ should be able to rapidly resume the bagging and sale of Compound "X". The local bag manufacturer should be able to provide NCZ with 70,000 bags per week, but supplies from this source are unreliable.

NCZ is manufacturing those compound fertilizers which make maximum use of the nitrogenous raw materials produced by NCZ. This helps to save on foreign exchange as well as to lower production costs. NCZ estimates the foreign exchange component of in Compound "X" at 31%.

Current production costs for Compound "X" are K 695 per M.T. NCZ estimates that it would have to produce at 70% of capacity to reach the point of breaking even. (NCZ's production costs are shown in Table 17.) NCZ officials indicate the N-P-K plant can operate at above nameplate capacity, but continued operations above 80% are unlikely because of the constraints imposed by the ammonia plant. A major constraint here is the urgent need for a new steam boiler representing $ 2 million in foreign exchange. Lesser constraints, associated with

the ammonia manufacturing process itself, include the inevitable poisoning of the catalyst and clogging of the heat exchanger.

The study team noted that the quality of product produced by NCZ was excellent. However, a major constraint to the distribution of NCZ fertilizer as a quality product is the lack of quality control at the bagging operations. The team observed ammonium nitrate (very hygroscopic in nature) being bagged in used bags in which NCZ had received raw materials. The plastic inner linings were not adapted to bagging machinery used in the plant. Hence in a substantial number of cases, the inner liners were not used or were simply allowed to fall to the bottom of the outside bag during the filling process. Of 19 bags that the team observed being filled, 6 had no inner liner. The remaining bags with inner liners were sewn in a manner that punctured the inner liners and would allow moisture to enter. These bags would not be able to move through the distribution channel or be stored for long without serious quality loss of the product.

Following up these observations on quality control, the team observed bags of fertilizer originating at NCZ which were improperly sewn.

Such carelessness in quality control is costing Zambia and contributing to the losses sustained in the fertilizer supply and distribution system. It is therefore recommended by the team, that the quality control standards for bagging at NCZ be improved to the same high level of quality standards enforced in the production of their fertilizers. This could substantially reduce losses in the distribution system.

Table 13

NITROGEN CHEMICALS OF ZAMBIA LIMITED - RAW MATERIALS
RECEIVED BY YEAR, MONTH, AND SOURCE IN METRIC TONS

MONTH AND YEAR, SOURCE	DAP	TSP	SSP	SOP	POTASH CHLORIDE	BORAX	NUFLO 10	AMM SULPH	TOTAL TONNAGE ALL MATERIALS
APRIL-NOV 1981 (USAID I)	3339	1633	650	1088	150	50	147	-	7057
DEC 1981 - AUG 1982 (USAID II)	6944	10940	271	6057	33	-	237	9995	34477
1981 - 82 SUBTOTAL USAID	10283	12573	921	7145	183	50	384	9995	41534
NOV-DEC 1982 CHEMIMEX	3451	1982		1544	-	-	-	-	6977
JAN 1983 CHEMIMEX	115	4	-	60	-	-	-	-	179
JUNE 1983 UNION VENEER	1104	3062	-	438	-	-	-	-	4604
APRIL 81-JUNE 83 ALL SOURCES	14593	17621	921	9187	183	50	884	9995	63294

SOURCE: Nitrogen Chemicals of Zambia Limited - 1983

Table 14a

NCZ TOTAL PRODUCTION, SALES, AND INVENTORY
FY 1981 - 82 IN METRIC TONS

MONTH	BEGINNING INVENTORY	PRODUCTION (MT)	SALES (MT)	ENDING INVENTORY
April	-*	1724	1618	106
May	106	3259	3216	149
June	149	452	488	113
July	113	1042	985	170
August	170	2195	2177	188
September	188	388	531	45
October	45	2220	701	1564
November	1564	1417	2884	97
December	97	4026	3034	1089
January	1089	2401	2469	620
February	620	4258	2679	2199

SOURCE: Calculated From Data Provision by NCZ.

*No beginning inventory figure available due to start up of new plant.

Table 14b

NCZ TOTAL PRODUCTION SALES AND FINISHED INVENTORY
FY 1982 - 83 IN METRIC TONS

MONTH	BEGINNING INVENTORY	PRODUCTION	SALES	ENDING INVENTORY
April	2199	9685	8746	3138
May	3138	8623	6534	5227
June	5227	7619	7815	5013
July	5031	5304	7832	2503
August	2503	5398	4262	3639
September	3639	8538	7047	5130
October	5130	1412	1412	5230
November	5130	6271	1830	9571
December	9571	5582	5678	9475
January	9575	3779	3037	10227
February	10227	4937	1140	14024
March	14024	3444	1552	15916

SOURCE: Calculated from Data Provision by NCZ.

Table 15a

NAMB/FERTS/225/83

NATIONAL AGRICULTURAL MARKETING BOARD
LOCAL PURCHASES (NCZ) FOR 1981
(IN MT)

MONTH	COMMODITY	QUANTITY
January	A/Nitrate	1971.90
February	A/Nitrate	751.95
March	A/Nitrate	1397.75
April	A/Nitrate	1649.40
May	A/Nitrate	3215.60
June	A/Nitrate	487.90
July	A/Nitrate	985.25
August	A/Nitrate	2177.25
September	A/Nitrate	506.30
October	A/Nitrate	220.60
October	X/Compound	518.55
November	R/Compound	1346.80
November	X/Compound	1537.15
December	A/Nitrate	789.75
	R/Compound	2244.20
		19800.35

SOURCE: Nitrogen Chemicals of Zambia Limited - 1983

Table 15b

LOCAL PURCHASES (NCZ) FOR 1982
(MT)

MONTH	A/NITRATE	R/C	D/C
January	1570.60	1634.70	-
February	1821.95	319.25	315.35
March	1140.25	-	1513.95
April	2503.60	-	6241.90
May	1762.55	-	4771.40
June	2152.45	-	5361.45
July	1308.25	2965.45	3558.15
August	1308.25	2056.90	-
September	2204.65	1555.20	-
October	398.60	1012.45	-
November	1412.05	418.45	-
December	3569.65	2147.65	-
TOTAL	21152.85	12109.60	21762.20

SOURCE: Nitrogen Chemicals of Zambia Limited - 1983

Table 15c

LOCAL PURCHASES (NCZ) FOR 1983

	A/N	R/C	X/C	C/C
January	2633.45	358.80	-	-
February	1209.90	-	-	-
March	183.90	2090.40	-	-
April	2815.65	3625.30	-	2777.20
May	1971.10	3774.05	1896.50	-
June	3420.85	2.90	2196.60	-
TOTAL	12234.75	9851.45	4093.10	2777.20

SOURCE: Nitrogen Chemicals of Zambia Limited - 1983

Table 16 RAW MATERIALS Vs NPKs PRODUCED BY NCZ

Fiscal Year (April 1-March 31)	Raw Materials				Finished Product
	Beginning Inventory (MT)	Products Received (MT)	Ending Inventory (MT)	Consumptions (MT)	NPKs Produced (MT)
1981 - 1982	-	38,609	25,570	13,039	11,335
1982 - 1983	25,570	24,685	14,976	35,279	45,454
1985 - 1984	14,976	NA	NA	NA	NA

Table 17 ACTUAL COST PER TON Vs. BUDGETED COST PER TON FOR MAJOR FERTILIZER MATERIALS (NCZ 1982 - 3)

ERTILIZER ATERIAL	Cost per Metric Ton				
	ACTUAL INCURRED COST/mr INK	US$* EQUIV	BUDGETED BREAKEVEN COST/mr INK	US$* EQUIV	SURPLUS OF (SHORTFALL) INK
MMONIA	917	742	835	676	82
ITRIC ACID	450	364	380	307	70
MMONIA NITRATE	730	591	616	498	114
MMONIA SULPHATE	820	664	633	516	182
OMPOUND V	-		702	568	
OMPOUND R	-		773	626	
OMPOUND C	-		702	568	
OMPOUND X	695	562	772	625	77

*US DOLLAR EQUIVALENT BASED ON EXCHANGE RATE OF .81K/$ AS OF JULY 8, 1983.

VII. FERTILIZER MARKETING AND SUPPLY ORGANIZATIONS

Zambia has a large number of institutions playing a role in the planning and execution of fertilizer marketing and supply. Different institutions are involved in fertilizer selection, production, procurement, pricing, distribution and education. Those involved in 1983 are cited below along with their major responsibilities:

1. The National Agricultural Marketing Board (NAMBOARD) is the most significant of all institutions involved in the fertilizer subsector. In consultation with the National Fertilizer Committee, it has final determination of quantities of fertilizers to be imported. In addition, it advises the Planning Division of the Ministry of Agriculture and Water Development (MAWD) on pricing, manages the importation of fertilizers, and is primarily responsible for the storage and distribution of fertilizers throughout the country to the regional level.

2. The Research Division of the Department of Agriculture in the Ministry of Agriculture and Water Development coordinates the activities of agricultural research. Zambia's 12 research stations and 17 zonal substations research and field test fertilizer products and make recommendations as to type, formulation, and use.

3. The National Fertilizer Committee advises NAMBOARD on the type and quantities of fertilizers to be imported. Committee members include representatives from MAWD, Commercial Farmers Bureau (CFB), Bank of Zambia (BOZ), Nitrogen Chemicals of Zambia, Ltd. (NCZ), Tobacco Board of Zambia (TBZ), National Federation of Cooperatives and bankers who finance fertilizer operations. The committee meets in April of every year.

4. The Central Supply and Tender Board tenders the fertilizer requirements on behalf of NAMBOARD. Tendering and receiving of quotations are finalized during July and August.

5. The Planning Division of MAWD determines and sets prices in consultation with NAMBOARD, the Ministry of Finance, the CFB and other concerned institutions. These prices are submitted to the National Commission for Development Planning and other agencies for commentary. Finally, the prices are submitted to the Cabinet for approval. Prices have been set largely on the basis of producer costs of production and what is considered to be a fair return. (See the section on fertilizer pricing.)

6. The Extension Service of MAWD has sole responsibility for fertilizer education and promotion in Zambia. It carries out fertilizer trials, farmer meetings, and advises individuals on what fertilizers to use, rates of application, and methods of application.

7. Nitrogen Chemicals of Zambia, Ltd. is the only industrial manufacturer of fertilizer in Zambia. Presently, NCZ produces about 30% of Zambia's fertilizer requirements. However, the plant is expanding its capacity such that by 1985 it will be able to satisfy approximately 80% of total domestic fertilizer demand.

8. The Ministry of Commerce and Industry has oversight of NCZ.

9. The Provincial Cooperative Marketing Unions have full responsibility for distribution of fertilizer and the procurement of gazetted commodities (such as maize) at the farm level. They purchase maize and supply rural primary cooperative societies with tools and farm supplies. The cooperative unions are federated under the National Federation of Cooperatives, and are represented on the National Fertilizer Committee by NFC.

10. The Ministry of Marketing and Cooperatives was recently established as a separate entity charged with oversight of the activities of the cooperative marketing unions and other forms of cooperatives. It assists in the formation of cooperative societies. This ministry was previously a department in MAWD.

11. The Bank of Zambia provides the needed authorization for allocations of foreign exchange essential to the importation of fertilizer raw materials and compounds. The BOZ also sits as a member of the National Fertilizer Committee.

12. Commercial Banks provide financing in the form of government guaranteed overdrafts to both NAMBOARD and the cooperative unions. In addition they issue the letters of credit in foreign exchange for fertilizer importation as authorized by the BOZ. Persons selected to represent the commercial banks sit on the National Fertilizer Committee.

13. Transporters such as Contract Haulage and Zambia Railways control the rolling stock which moves the fertilizer from port to destinations in Zambia.

14. Port authorities at Dar es Salaam, Beira and East London control the handling of fertilizer at the respective ports.

The study team found that the multiplicity of organizations and the complex inter-institutional relationships of which the fertilizer supply and marketing system consists have hindered and made difficult timely and accurate decisions essential to the efficient operation of the system. The fragmentation of planning and executing the supply and marketing of fertilizer has been amplified by the newly instituted relationships between NAMBOARD and the cooperatives. The shift of responsibility of rural distribution of inputs and procurement of

commodities from NAMBOARD to the cooperatives has been an immense burden to the cooperatives, which most were not prepared to handle. There have been resulting breakdowns in communications, financial flows and the chain of responsibility. In addition, various donor groups are endeavoring to assist with the development of the fertilizer system. There is lack of overall coordination of these efforts. Information flows and financial flows essential to fertilizer procurement of imported and locally produced fertilizer often cause untimely delays. The slow process of decision-making and the hindered information and financial flows have all resulted in the system not delivering fertilizer to the farmer in a timely fashion.

Information flows, product selection, appropriate pricing, management of the production and procurement, management of the delivery system, fertilizer education, personnel development, all must be executed and controlled in a unified manner from the source of supply to the farm gate. This points to the need for an organization specifically structured to manage the marketing and supply of fertilizers. This organization should be provided with enough autonomy to carry out all the marketing functions. It should be held accountable for putting the right product at the right place, at the right time and for helping to insure its correct use. The problems and issues associated with the fragmented nature of the system will be elaborated and documented further in the sections of the report which follow.

VIII. THE PHYSICAL DISTRIBUTION SYSTEM

In this section, the system for distributing fertilizer is documented with respect to physical control, ownership and the inventory nodes (places where fertilizer stops and is stored) along the way. The report also analyses the method of handling and frequency of handling as fertilizer moves along the system.

A. PHYSICAL CONTROL

A large number of organizations have physical control of fertilizer as it moves through the distribution system. Figure 7 depicts the flow of product from exporter to farmer. The finished product must pass under the physical control of up to twelve agencies in the process of distribution. In some circumstances the product may move more directly to commercial farmers. However, even under this shortened route the product falls under the physical control of 8 to 10 different units in the system.

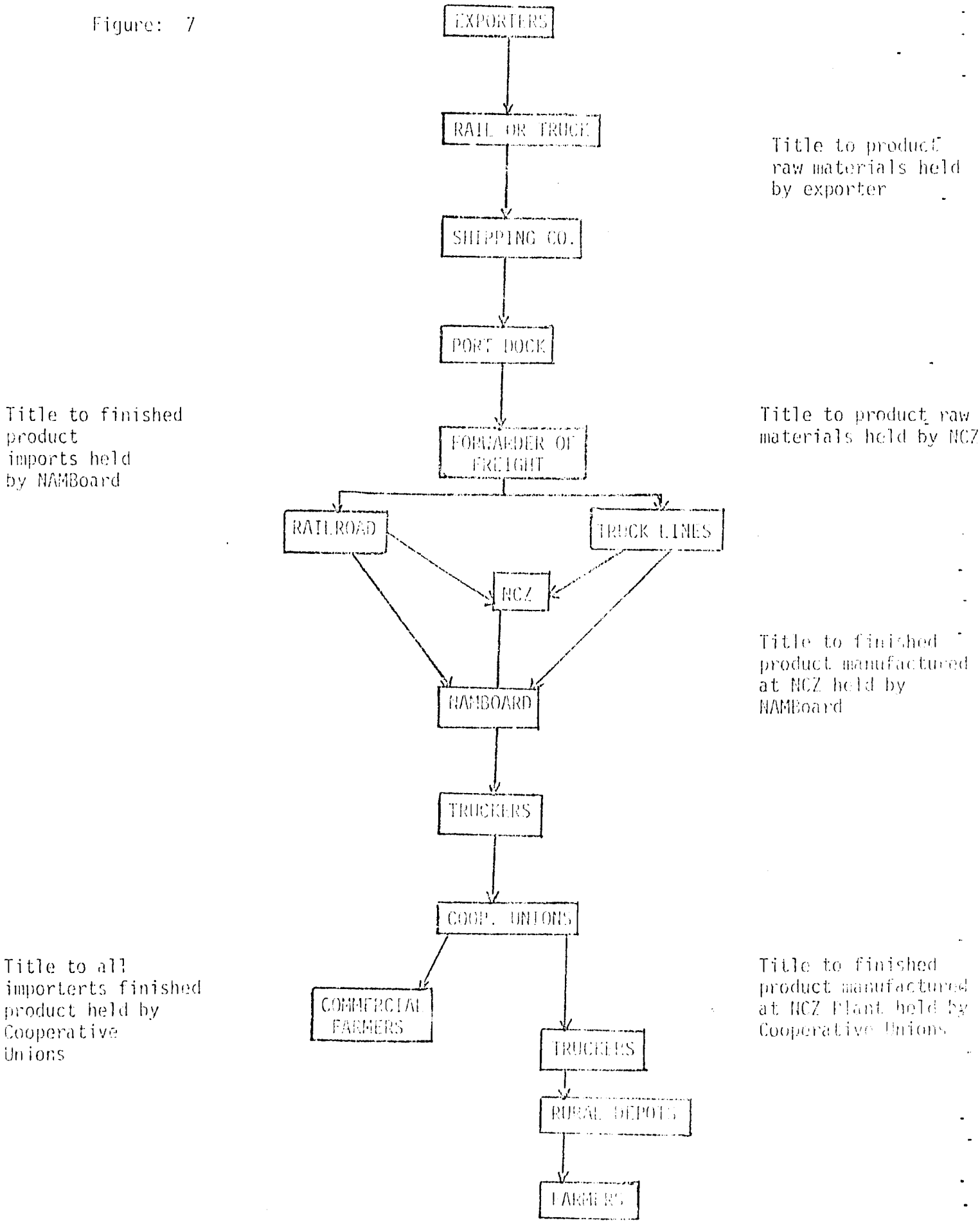
The large number of organizations having physical control of the product creates problems of accountability and opportunities for losses and shrinkage. Effective controls are difficult to establish and administer. The fact that imports of finished product and raw materials come from a number of sources further complicates the matter of control.

B. FINANCIAL CONTROL

Title to the product in the physical distribution channel rests in the hands of four organizations. Purchasing tenders are most commonly written for CIF to the dock at one of the ports of entry. Title up to this point for both finished fertilizer products and intermediate raw

ORGANIZATIONS AND AGENCIES WITH PHYSICAL CONTROL AND TITLE* OF FERTILIZER MATERIALS IMPORTED INTO ZAMBIA

Figure: 7



* Assumes CIF dock in Port of Entry

materials rests in the hands of the exporter.

Once the fertilizer is landed, title to the finished fertilizer products is turned over to NAMBOARD. Title to fertilizer which will be further processed is turned over to NCZ. These parastatal agencies own the product during the transportation into Zambia by truck or rail.

Title to finished products is generally maintained by NAMBOARD until the fertilizer is purchased by the cooperative unions. Some fertilizer is sold by NAMBOARD directly to large scale commercial farmers.

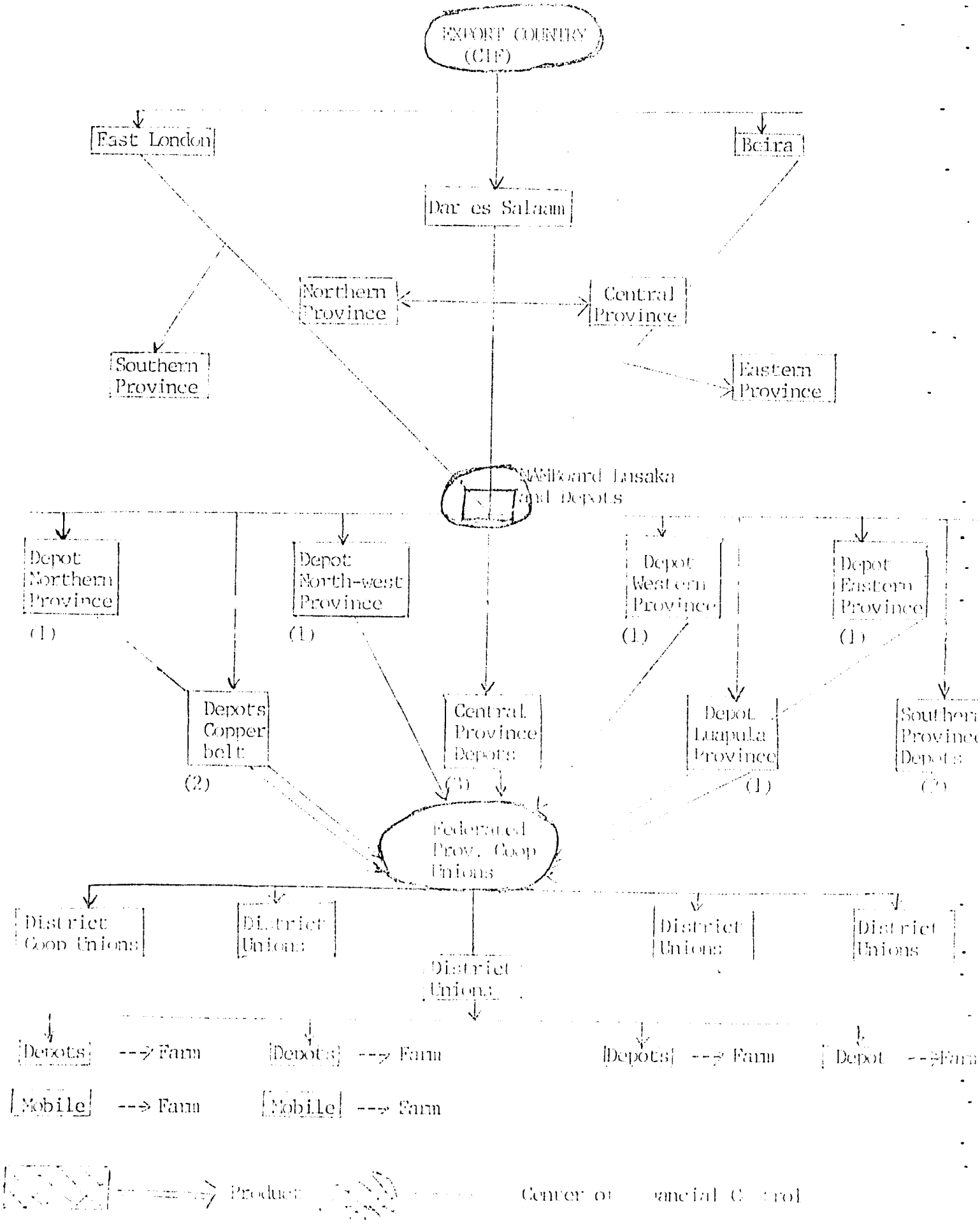
Title to fertilizer materials needing further processing is held by NCZ until processing has been completed and the finished products are purchased by NAMBOARD. The title is then turned over to NAMBOARD with the finished products which will be distributed to provincial cooperative unions. The cooperative unions own the fertilizer as it moves through their district depots to their rural depots for sale to the farmer.

Of the three Zambian organizations holding title to the product, NAMBOARD holds title the longest and over the greatest distance. NCZ maintains ownership of raw materials for relatively long periods but usually sells the finished fertilizers to NAMBOARD promptly. The cooperative unions by comparison, own the fertilizer products for relatively short periods and distribute them over relatively short distances. Roads, bridges and terrain in these short distances are often more difficult to travel.

C. PHYSICAL FLOWS

1. An Overview - The physical flows are shown in Figure 8 for finished fertilizer products entering Zambia. The assumption is made that the product is purchased CIF dock at one of three ports of entry, East

FIGURE 8 : PHYSICAL FLOW OF FERTILIZER PRODUCE AND CENTRES OF FINANCIAL CONTROL FOR PRODUCE THROUGH THE COOPERATIVE DEPOTS AND MARKBOARD



London, South Africa, Beira, Mozambique or Dar-es-Salaam, Tanzania. Most of the fertilizer moves by rail from either East London or Dar-es-Salaam.

From the port of entry, the product moves either by truck or rail into Zambia. As indicated in the previous diagram some fertilizer may be delivered directly to NAMBOARD regional warehouses. This is particularly true where the product is moving along the "line of rail" from East London or Dar-es-Salaam. Some fertilizer is shipped by rail directly to line of rail depots owned by the cooperative marketing unions in Southern, Central and Northern provinces.

Fertilizer not moved directly as above, is transported to the Lusaka Central Depot owned by NAMBOARD. From this point, fertilizer is dispatched to the remaining regional warehouses in Copperbelt, Northwestern, Western, Luapula and Eastern provinces. After the product has been delivered to the provinces and placed in the NAMBOARD warehouses, it is purchased by the cooperative unions. The cooperative union in each province then moves the product to their depots in each district, where it is stored in preparation for movement to the local rural depots where it will be sold to farmers. In some cases temporary or mobile sales centers are set up and serviced by the unions in order to move the product closer to the final user. Following is detailed a description of fertilizer movement from each of the three ports and from NCZ to the various locations in Zambia

2. Fertilizer Movement from the Ports and NCZ - Currently 70% of Zambia's fertilizer purchases are imported while the remaining 30% is locally produced by NCZ in Kafue. This section traces the movement of fertilizer from the three above mentioned ports and from NCZ to the NAMBOARD depots and cooperative union depots. Typically, the

provincial cooperative unions purchase fertilizer from the various NAMBOARD depots and sell to farmers through their rural selling points. (As mentioned above exceptions exist along the line of rail. Also NAMBOARD sells directly to some farmers at its own depots.)

a. From East London.....

This port is situated on the Eastern Coast of South Africa and handles a large portion of Zambia's fertilizer imports.

The Commericial and Freight Department of NAMBOARD informs the clearing agent (Manica Freight) at the port on how the fertilizer should be distributed to the various stations in Zambia. This insures that all fertilizers meant for use in Southern Province will be dropped at depots en-route to Lusaka.

When ships dock, fertilizers are moved to warehouses to aweit railing into Zambia. The loaded railway wagons enter Zambia through Livingstone. Figure 9 traces the movement of fertilizer from Livingstone to the other parts of the Country.

.....1) to Southern Province

NAMBOARD operates from two branches in the Southern Province, namely Livingstone and Monze. At receiving time, NAMBOARD places its representatives at Kalomo and Mazabuka depots (belonging to Southern Province Cooperative Union). These depots along with the Choma/NAMBOARD depot receive the fertilizer and then transfer it to other cooperative union depots.

.....2) to Lusaka Central[*]

The rest of the fertilizer goes on to the Central Warehouse in Lusaka for distribution to other branches in the country.

Footnote: Lusaka serves not only as a national distributing center,

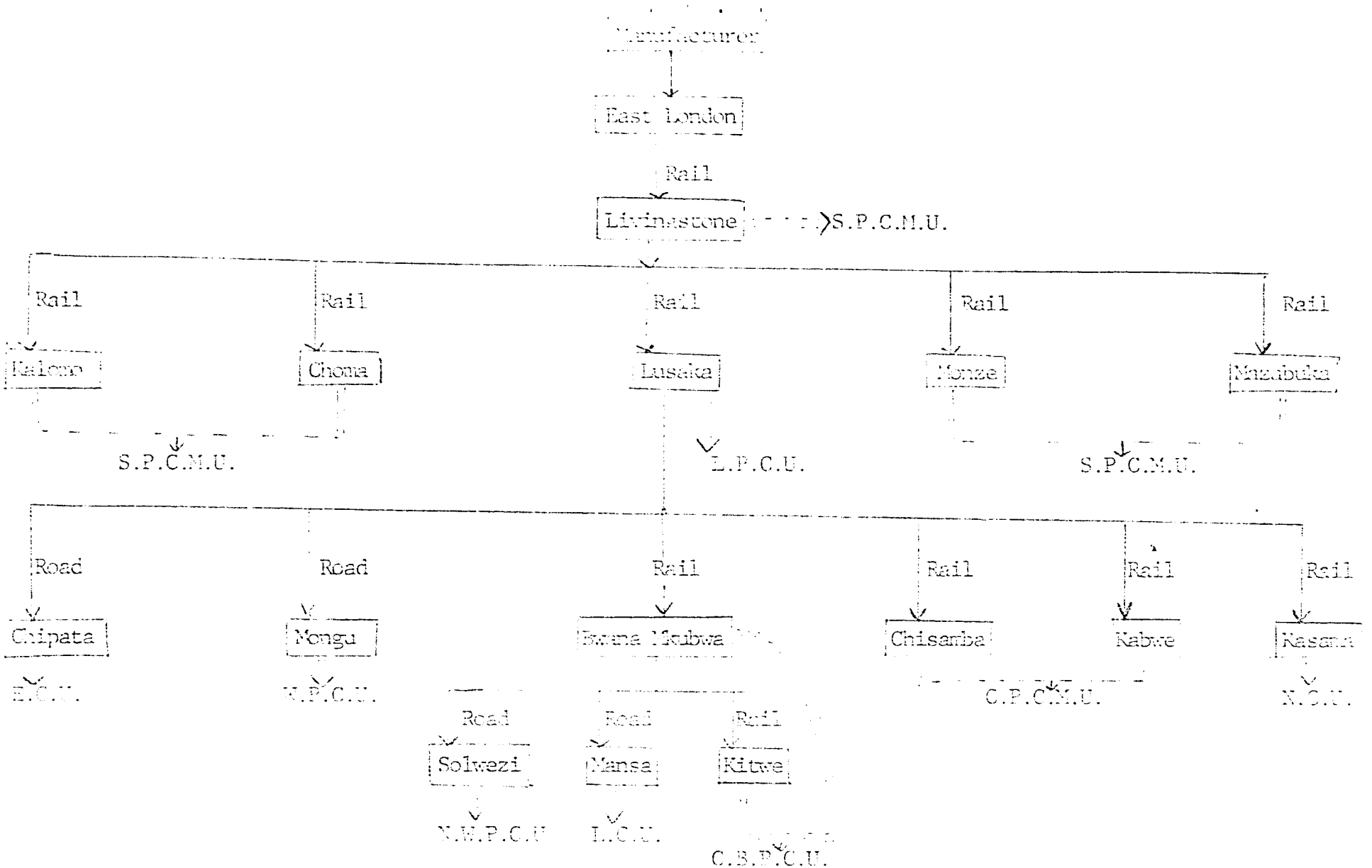


Figure: 9 - Fertilizer Flow through East London

but also as a supplier of all fertilizer requirements for the Lusaka Province Cooperative Union.

The movement of fertilizer from the port of East London to Lusaka is entirely by rail.

From Lusaka Central Warehouse the rest of the fertilizer is moved to the rest of the Zambia as follows:

.....3) to Eastern Province

From Lusaka, fertilizer is loaded into trucks for road haulage to Eastern Province. NAMBOARD has only one operating point in the province at Chipata. There are however, three Eastern Province Union depots en-route to Chipata. At these depots at Petauke, Katete and Sinda, NAMBOARD sends its representatives to supervise the receipt of the fertilizer and transact the sale to the Union. The rest of the fertilizer moves on to Chipata, where it is finally sold to ECU.

.....4) to Western Province

This province has one NAMBOARD warehouse at Mongu. Fertilizer requirements for the Province are sent to Mongu by road and sold to the Western Province Cooperative Union. Small quantities are dropped at Kaoma, a cooperative union depot on the way to Mongu. A NAMBOARD representative receives the fertilizer and sells it to the Union.

.....5) to Central Province

This province has two NAMBOARD depots, one at Chisamba and the other at Kabwe. Fertilizer is moved from Lusaka to these two branches by rail. The fertilizer is then sold to the Central Province Cooperative Union.

.....6) to Copperbelt Province

This province serves as a distributing point to Northwestern and Luapula provinces. Fertilizer moves from Lusaka t Bwanamkubwa depot

in Ndola by rail. From here, small quantities are moved to Kitwe and by rail. These two towns supply fertilizer to the Copperbelt Province Cooperative Union. The rest of the fertilizer is hauled to Solwezi and Mansa by road which supply fertilizer to the Northwestern Province Cooperative Union and Luapula Province Cooperative Union respectively.

.....7) to Northern Province

The NAMBOARD depot in the province is situated at Kasama. Fertilizer is moved from Lusaka to Kasama by rail where it is sold to the Northern Province Cooperative Union.

b. From Beira.....

This port is situated centrally on the Mozambican coast and handles fertilizers coming into Zambia through the Eastern route.As with the port of East London, the clearing agent at Beira (Manica Freight) is also given a distributing schedule by the Commercial and Freight Department of NAMBOARD.

Figure 10 shows the movement of fertilizer from the port of Beira. The fertilizer is moved by rail from the port to a railway siding called Moatize, within Mozambique. From this point, Zambian truckers haul the fertilizer into Zambia.

.....1) to Eastern Province

All the fertilizer to be used in Eastern Province is dropped at the NAMBOARD regional depot at Chipata or along the way to Lusaka at the Eastern Province Cooperative Union depots at Katete, Sinda and Petauke.

.....2) to Lusaka Central

Fertilizer for the rest of the country goes to Lusaka for distribution to other parts of the country.

.....3) to Western Province

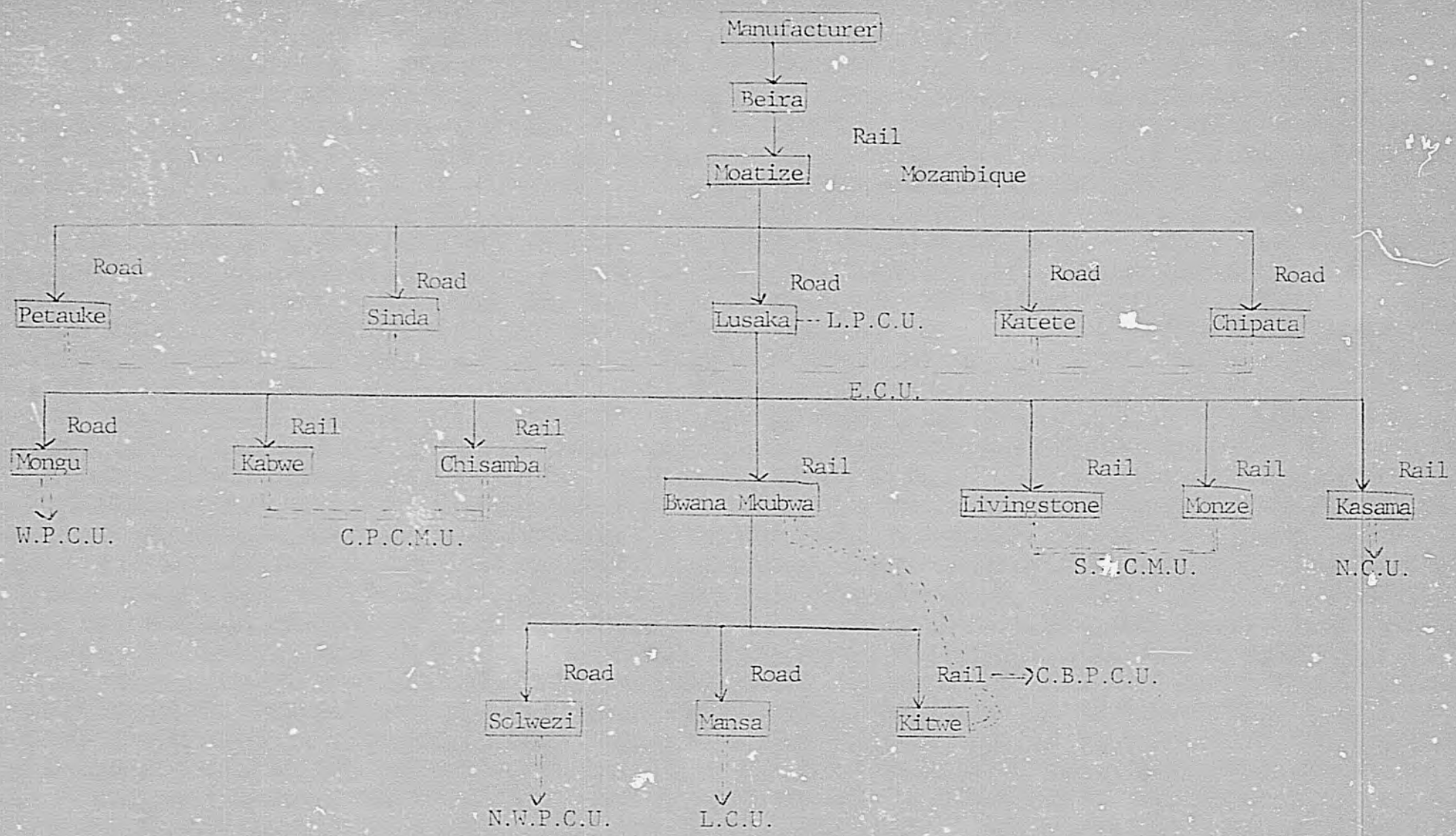


Figure 10 - Fertlizer Flow through Beira

Fertilizer is hauled from Lusaka to Mongu NAMBOARD depot by road for sale to the cooperative union. Part of the fertilizer is dropped in Kaoma Union depot as previously described.

.....4) to Central Province

From Lusaka, fertilizer is railed to Kabwe and Chisamba NAMBOARD depots where it is sold to the Central Province Cooperative Union.

.....5) to Copperbelt Province

Bwana Mkubwa NAMBOARD depot again serves as a distributing point for Northwestern and Luapula provinces in addition to supplying fertilizer to the Copperbelt Province Cooperative Union. Movement to Solwezi and Mansa is again by road.

.....6) to Southern Province

Fertilizer is railed from Lusaka to Monze and Livingstone NAMBOARD depots for sale to the Southern Province Cooperative Union.

.....7) to Northern Province

Fertilizer is railed from Lusaka to Kasama NAMBOARD depot where it is eventually sold to the Northern Province Cooperative Union.

c. From Dar-es-Salaam.....

The port of Dar-es-Salaam handles all fertilizer imports coming into Zambia through the Northern route via the TAZARA Railroad system. In Dar-es-Saleam, Kariba Freight clears all NAMBOARD fertilizers and loads them into rail wagons. The clearing agent is given a distributing schedule showing how the fertilizer should be distributed in Zambia. Figure 11 shows product movement from the port of Dar-es-Salaam.

.....1) to Northern Province

There is one Northern Province Union depot at Mpika where some fertilizer is received by a NAMBOARD employee who then sells it to the union. The rest for Northern Province goes to Kasama NAMBOARD depot

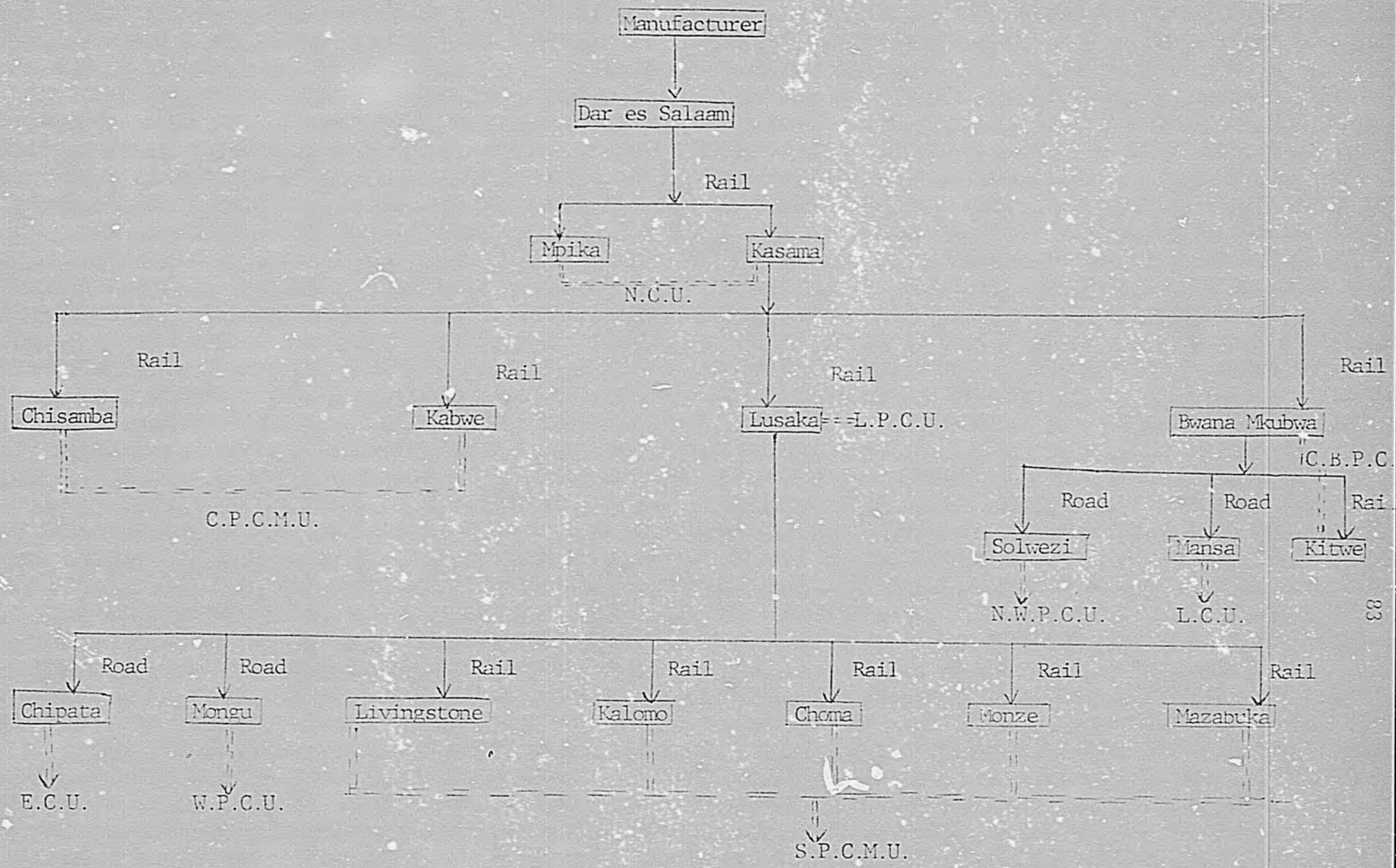


Figure 11 - Fertilizer Flow through Dar-es-Salaam

for sale to the union.

.....2) to Lusaka Central and Bwana Mkubwa in Copperbelt

The rest of the fertilizer for the other parts of the country is railed to Lusaka and Bwana Mkubwa for further distribution.

.....3) to Central Province

Fertilizer requirements for Central Province are railed directly from the port to Kabwe and Chisamba where the fertilizer is sold to the union.

.....4) to Copperbelt

From the port, fertilizer is railed to Bwana Mkubwa NAMBOARD depot for distribution to Solwezi (Northwestern Province), Mansa (Luapula Province) and the rest to Kitwe. These depots sell the fertilizer to their respective cooperative unions.

.....5) to Eastern Province

From Lusaka, fertilizer is loaded into trucks for road haulage to the respective NAMBOARD and provincial depots mentioned above for Eastern Province

.....6) to Western Province

Same route and mode as described from other ports...

.....7) to Southern Province

Same route and mode as described from Beira

3. Transport within Provinces to Rural Sales Centers

d. From Nitrogen Chemicals of Zambia....Nitrogen Chemicals of Zambia supplies the country with 30 per cent of the total fertilizer requirement. Figure 12 shows product movement from N.C.Z.

.....1) to Southern Province

The finished product is distributed from N.C.Z. to the Southern Province by rail. The fertilizer is stored by NAMBOARD at Monze and

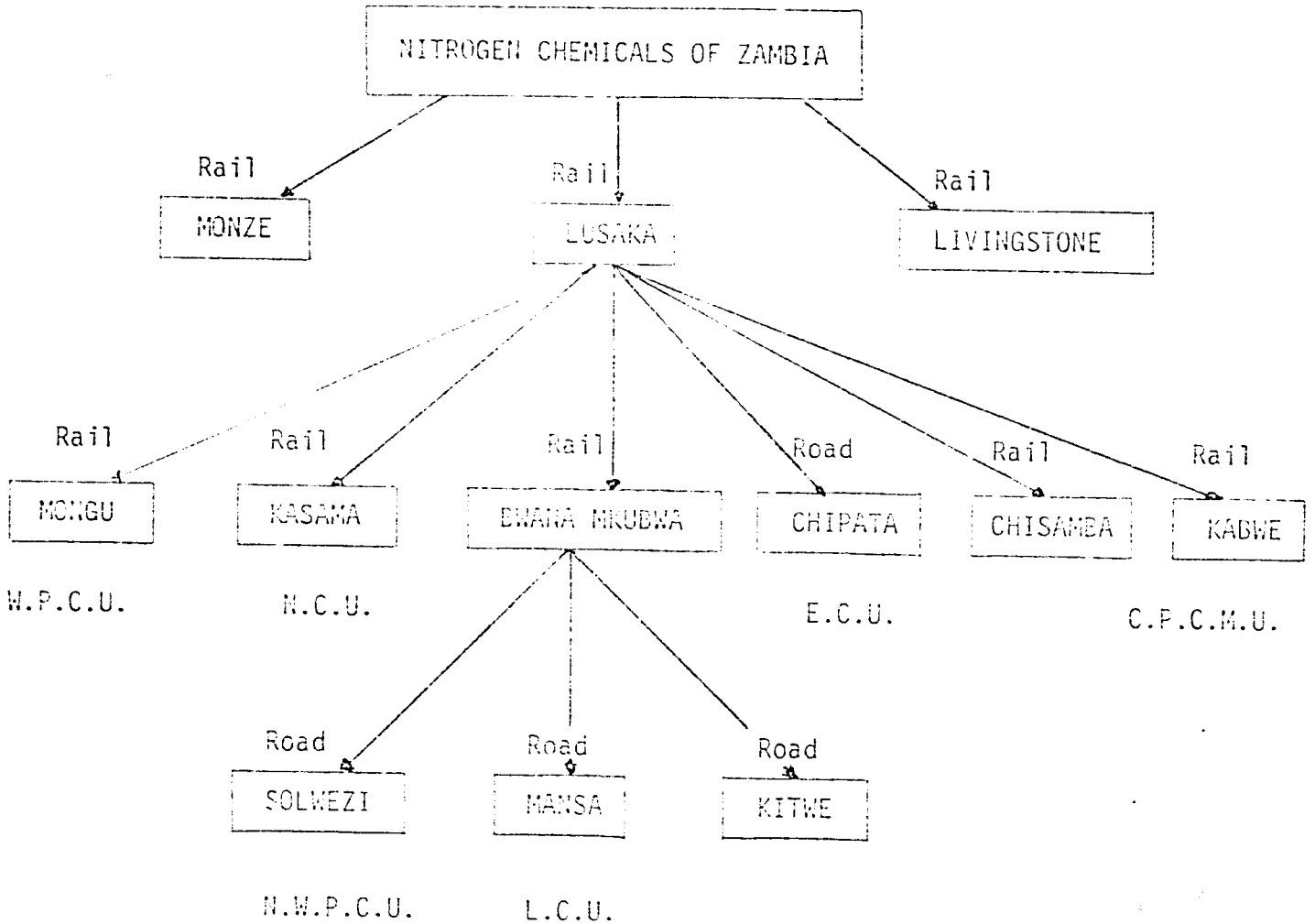


Figure 12 - Fertilizer Flow From NCZ

Livingstone branches as well as the newly opened sheds in Choma to await purchase by Southern Province Cooperative Marketing Union.

.....2) to Lusaka and points beyond

The rest of the fertilizer is railed to Lusaka for distribution to other provinces. Fertilizer for Northern, Central and Copperbelt Provinces is reconsigned from Lusaka to the NAMBOARD provincial warehouses by rail to await collection by the respective cooperative unions. Copperbelt supplies Northwestern and Luapula Provinces by road.

Eastern and Western Provinces get their fertilizer requirement by road from Lusaka and supply the respective cooperative unions.

D. ORDER AND DISPATCH FLOWS

The process of ordering and dispatching the above movements of fertilizer bares further commentary at this point especially as it relates to fertilizer going to NAMBOARD regional distribution centers and as it relates to fertilizer going to the various cooperative unions.

1. Within the NAMBOARD System of Regional Warehouses - The flow of fertilizer in NAMBOARD's part of the distribution system is guided by a series of orders to NAMBOARD from regional depots and dispatches from NAMBOARD headquarters. Since as much of the product is moved directly to regional NAMBOARD warehouses or cooperative union depots as is practical, the ordering and dispatching procedure contains direct drop orders as well as transhipment orders through Lusaka Main depot. The procedure for order placement begins at the regional level. The regional depot places an order against its forecast estimate to the FIPS Division of NAMBOARD. The order is then evaluated and may be

either accepted or reduced at the FIPS level.

At this point the order may be filled in one of three ways. It may be filled by the Lusaka main depot. In this event, the dispatch order would be sent to the Lusaka depot where the invoice and bill of lading would be prepared and the load dispatched to the appropriate provincial warehouse. Seven of the warehouses would be served in this way. (Northwestern and Luapula provinces are excepted)

A second way the order may be filled is for the FIPS manager to contract one of the freight forwarding firms at one of the three ports. The forewarder would be given an order (distributing schedule) to drop the shipment enroute to Lusaka at the regional warehouse placing the order. If the regional order originated in Eastern Province, for example, the forewarder in Beira would be asked to dispatch a portion of an imported shipment of fertilizer received directly to the Eastern Province NAMBOARD regional warehouse. The remainder would be sent to Lusaka where it would be unloaded or would be transhipped directly to another warehouse against another order.

A third way for the order to be filled involves only NAMBOARD regional warehouses in Luapula and Northwestern provinces. The FIPS Manager in these two warehouses would dispatch the order from the regional NAMBOARD warehouse in Copperbelt Province.

NAMBOARD's efforts to move fertilizer as directly as possible to the regional depots rather than through the main depot in Lusaka is to be commended. Discussion of the constraints to efficiency in the order and dispatch mechanism will be presented later.

2. Between NAMBOARD and the Cooperative Unions - The flow of fertilizer between NAMBOARD warehouses and the provincial cooperative unions is triggered by orders from the cooperative unions. The order information

is based upon forecasted volume requirements from the various districts in the province. It is the perception of the study team that orders are not made either at the rural depot/society level or at the district level of the cooperatives. Rather, the provincial cooperative union makes the decision as to when orders are placed, which products are to be delivered to which depots and how delivery will be made to the district depots. District depots are in turn charged with distributing product down to the local sales centers (depots).

E. HANDLING FERTILIZER

As mentioned in a previous section, the dominant packaging of fertilizer used in Zambia is the 50 Kg. lined plastic pocket (bag). Fertilizer imported into Zambia is specified to be shipped in 50 Kg. pockets, labeled as specified by NAMBOARD to indicate the compound contained. As a rule, the fertilizer is bagged in the country of origin.

The path through the distribution channel results in a large number of handlings for the 50 Kg. pockets. Figure 13 traces the path followed by a typical 50 Kg. pocket of fertilizer imported into Zambia, indicating the number of handlings needed at each stage. The fertilizer is hand-moved approximately 30 times from the exporter's port warehouse bagging operations at the foreign port to the farmer's field in Zambia. In many cases, there will be additional handlings of the pocket of fertilizer on docks and in warehouses. The fact remains that most pockets will be picked up, carried and set down at least 30 times before they are opened for use.

The multiple handlings put stress on the packaging material and greatly increase the probability of damaging a pocket before it reaches the final user. In fact, if a modest amount of damage such as 0.8-1.0%

FIGURE 13: HANDLING OF A BAG OF FERTILIZER FROM EXPORTER TO FARMERS FIELD

LOCATION OF PRODUCT IN CHANNEL	MOVEMENT OF PRODUCT	TOTAL CUMULATIVE TIMES HANDLED	CUMULATIVE NUMBER OF TIMES HANDLED UNDER CONTROL OF EXPORTER	NCZ	NAMBOARD	UNION	FARM
Exporter Port Wharehouse	Into truck or rail car	1	1				
Export Dock Dock	Out of truck on rail car into ship	3	3				
Import Dock Dock	Out of ship onto truck	5	5				
Port Warehouse	Out of truck into warehouse	7		2	2		
Rail/truck	Out of warehouse into rail/truck vehicle	9		4	4		
NAMBoard Central Depot or NCZ	Out of truck or rail car into warehouse	11		6	6		
Truck	Out of control warehouse into truck	13			8		
NAMBoard Prov. Depot	Out of truck into Depot warehouse	15			10		
Truck	Out of warehouse into truck	17			12		
Cooperative District Depot	Out of truck into depot warehouse	19			13	1	
Truck	Out of depot into truck	21				3	
Cooperative Rural depot	Out of truck into sales center	23				7	
Farmer Transport	Out of sales center into truck/wagon/car	25				8	1
Farm storage	Out of farm vehicle into storage	27					3
Farm vehicle	Out of storage into vehicle	29					5
Field	Out of storage onto farm	30		6	13	8	6

occured with each handling, the accumulated shrinkage losses in product would fall in the range of 25-30% by the time the product reaches the final user.

The financial liability for losses in the fertilizer increases as the product moves through the distribution system and becomes continually more valuable. Value added by transportation and inventory holding at higher levels in the channel are automatically included in the value of the fertilizer at lower levels. Hence the cost of a ton of loss becomes greater as the fertilizer moves along toward its final destination. The net result of this implies that the percentage of financial cost of losses sustained from multiple handlings may exceed the 25-30 percent physical loss mentioned above. Figure 13 also shows the number of movements under ownership of various agencies in the distribution channel.

Of the approximately 30 times that a bag of fertilizer is moved, it is under NAMBOARD ownership for 13 or more handlings. About 8 of the handlings occur while the fertilizer is owned by the cooperative and about 6 occur at NCZ where raw materials are brought in for fertilizer manufacturing. The greatest burden and risk of physical loss is therefore borne by NAMBOARD. Since the fertilizer is sold at a uniform price, the greatest financial cost of losses is also borne by NAMBOARD.

The number of times the fertilizer is handled contributes significantly to both fertilizer losses and to the financial cost of those losses in the distribution system. The fact that it is reasonable to expect a shrinkage of 25 to 30 percent from the original volume ordered, indicates that current packaging, handling, storage and transportation of fertilizer products need to be carefully

re-evaluated.

F. CONSTRAINTS IN PHYSICAL DISTRIBUTION

A number of constraints relating to the fertilizer distribution system were identified by the study team. These are examined below. Alternatives are presented that may alleviate the constraints.

1. Fertilizer Movement from Port to NAMBOARD - Currently the bagged fertilizer is moved either by truck or in open gondola rail wagons. Fertilizer shipped from the port is taken from ship hold and moved to a port warehouse away from the dock. (Because NAMBOARD already holds title to the fertilizer at this point, it bears the financial risk, even though the forewarder has physical control.) From this point they await the availability of rail wagons or trucks. Rail shipment or truck shipment to NAMBOARD can be expected to follow in from 3 to 6 weeks. From NAMBOARD documents it was determined that fertilizer moved from port by open gondola wagons incurred serious losses. Table 18 shows the quantity shipped from port versus the quantity received in Zambia for the five month period from October 1982 to February 1983. On 23 wagon loads shipped, averaging 40.8 metric tons per wagon at the port warehouse, an average of 38.9 metric tons per wagon was received by NAMBOARD. This represents a loss of about 2 tons per rail wagon or 5 percent of the fertilizer shipped. According to discussions with NAMBOARD officials, losses were judged to be somewhat greater in shipments from Dar-es-Salaam than from East London.

This loss, added to the shrinkage incurred during shipment up to port and the handling of the fertilizer at the port, may reduce the tonnage of fertilizer actually arriving in Zambia from the tonnages shipped by 8 percent. The value of the loss at this point would be approximately K30 per ton or K1.50 per 50 Kg. pocket.

Table 18

AVERAGE QUANTITY OF FINISHED FERTILIZER PRODUCT INVOICED
VS
AVERAGE QUANTITY SHIPPED PER RAIL WAGON
OCT. 1982 - FEB. 1983 WITH AVERAGE PERCENT SHRINK

	(Quantity Invoiced)		(Quantity Received)	
LOAD	BAGS	METRIC TONS	BAGS	METRIC TONS
1	780	39	776	38.8
2	780	39	780	39.0
3	780	39	751	37.5
4	860	43	860	43
5	780	39	780	39
6	860	43	860	43
7	860	43	829	41.5
8	780	39	771	38.5
9	860	43	819	41
10	860	43	838	42
11	780	39	736	36.8
12	860	43	860	43
13	780	39	757	37.8
14	860	49	824	41.2
15	860	43	829	41.5
16	780	39	704	35.2
17	780	39	761	38
18	780	39	716	35.8
19	780	39	759	38
20	860	43	670	33.5
21	780	39	780	39
22	780	39	744	37.2
23	860	43	694	34.7
Average	814.8	40.8	778	38.9

Average 1.9 ton Shrinkage per Wagon
Average 4.9% Shrinkage per Wagon

SOURCE: CALCULATED FROM DATA PROVIDED BY NAMBOARD

Alternatives to reduce the losses are limited, since the fertilizer is not under the physical control of NAMBOARD during the movement through this portion of the system. Undoubtedly the shipping in open gondola cars contributes to the problem. The current major alternative open to NAMBOARD is tendering the fertilizer for CIF Livingstone, Lusaka or some other point within Zambia. This would allow for greater control of the product by NAMBOARD and a shorter distance and time when the product is physically controlled by other organizations.

The tender price per ton would necessarily be greater by at least the cost of transport. However, an additional K30 per ton above the cost of transport would be justified. The fact that the lost fertilizer represents loss of valuable and scarce foreign exchange makes this alternative even more justifiable.

Further attempts to monitor losses in transit within Zambia should be made. A regular system of comparison between quantity invoiced and quantity received should be made. A regular system of comparison between quantity invoiced and quantity received should be pursued for both truck and rail shipments within Zambia's borders as well as outside the borders.

2. Warehousing Facilities at NAMBOARD Depots - At the present time, warehousing at the NAMBOARD depots is being upgraded through the construction of new facilities at key locations by the Canadian International Development Agency. Table 19 gives the locations of these storage facilities and their number and capacity. Visits by team members to these facilities confirm that these improved storage facilities will reduce losses.

At all other observed storage depots, a sizeable quantity of

Table 19

NAMBOARD-CIDA PROJECT

The Canadian Internatoinal Development Agency (C.I.D.A.) has constructed fertilizer storage sheds for Namboard at the following points:-

District	No. of Shed	Capacity/Shed (Tonnes)	Total Capacity (Tonnes)
Choma	5	3,500	17,500
Chipata	2	3,500	7,000
Katete	2	3,500	7,000
Petauke	1	3,500	3,500
Lundazi	1	3,500	3,500

These sheds will be manned by Namboard employees who will be conducting sales to provincial cooperative unions.

fertilizer was stored outside on hardstands or on the ground. The use of such outdoor storage was necessary because the covered warehouses were full.

The team also observed a sizeable amount of wet, lumpy and otherwise damaged fertilizer at both indoor and outdoor storage locations. Although this fertilizer is still carried on the inventory, it is unlikely that NAMBOARD will be able to sell it to the cooperative unions without a substantial discount in price.

A major alternative has been pursued by the NAMBOARD/CIDA project as mentioned above. A second alternative would be to move the fertilizer on down the channel to the cooperative without intervening handling or storage.

Observations in Eastern Province revealed a build-up of fertilizer in the NAMBOARD facilities to the point where outside storage was necessary, while at the same time empty covered storage was available in district depots managed by the Eastern Province Cooperative Union. This sort of bottleneck in the system results in several undesirable conditions:

1) more storage is necessary at the regional NAMBOARD depots for a relatively short period of time;
2) the utilization of existing covered storage capacity is much lower than would be efficient at both NAMBOARD and the cooperative depots;
3) the product is more remote from the end user, making it more difficult to provide the fertilizer the farmer needs on a timely basis;
4) there is an increased likelihood that a premium will have to be paid for transport to district depots.

The study team did not collect adequate numerical information on the shrinkage at warehouse locations to completely analyze the losses there. NAMBOARD is making an extra-ordinary effort to control inventories. Detailed weekly stocks reports are submitted by the NAMBOARD regional depots to the headquarters in Lusaka (Kwacha House). These reports are to be based on physical inventories taken weekly.

However, the team observed stacks of bagged fertilizer five years old in one regional warehouse. This unuseable product is obsolete merchandise that is no longer recommended. In another regional warehouse, (one of the new CIDA facilities) stacks of badly damaged fertilizer were placed in a far back corner of the building where they will be inaccessible. Fertilizer which is obsolete or otherwise unuseable should be disposed of at salvage value as soon as possible to make additional warehouse space available for quality products currently being kept outdoors. There is no value in keeping unuseable stocks on the inventory.

3. Constraints in Product Packaging and Handling - Mention has been made of the damage caused by the multiplicity of handlings required in the current system. The pockets of fertilizer may be damaged in a number of ways. Once the pocket is damaged, there is a likelihood that all or part of the contents will be spilled and lost. Even though some of the fertilizer may remain in the damaged bag, its hygroscopic (moisture attracting) nature makes the probability of the fertilizer spoiling and being lost very high.

There is some chance that prompt rebagging after a pocket is damaged could save a large portion of the contents. However, procedures and facilities for rebagging promptly are not available at

most points in the system.

Alternatives for reducing constraints due to packaging and handling include the following:

1) delay bagging the compounds until the product has moved further into the channel;
2) reduce the number of inventory nodes in the distribution channel so that the product must be handled fewer times as it moves through the system;
3) use alternative packaging such as "mini-bulk" 1000 Kg. bags for a portion of the movement through the system
4) adopt unitization of pockets for a portion of the movement the system;
5) Change the handling techniques used in warehouses to reduce damage.

Delaying the bagging of the fertilizer compounds would require equipment and trained personnel at either the port facilities or at some point or points in Zambia. The cost of the equipment and training needed plus the need for appropriate rail equipment are problems with this alternative. The team did not cost out this alternative, however, it should not be dismissed without further investigation, since the reduced losses of fertilizer might more than cover the additional cost.

Alternatives for shortening the distribution channel are limited at the present time. Shipments by rail or truck from port are now routed directly to regional NAMBOARD and cooperative union district depots whenever this is possible. This should be continued. The fact that the regional warehouse space may be full can be a constraint to these more direct movements. It is therefore wise, as stated before, to move the product down the channel as soon as possible to the

cooperative warehouses. While there is a limit to the good quality covered storage currently available, existing storage at the district level is being underutilized. (See Asthana and DiBiase for a detailed description of the current storage situation.)

The use of "mini-bulk" containers is an alternative that warrants further investigation. The mini-bulk container is durable, making possible reduction in fertilizer losses during handling. The mini-bulk container is reuseable as well, a means of cost savings. Mini-bulk movement would require special equipment at the ports, which may or may not be available. The potential savings of this system merit further investigation and costing of this alternative.

Any alternative where bagging will be done in Zambia will put a stress on the supply of proper pockets, a problem already constraining the system but which should be overcome. This could be solved by having consignments of the necessary bags shipped with the fertilizer shipment.

A major constraint in the current system is the multiple handlings of pockets throughout the distribution path from the port to final user i.e. the lifting, carrying and placing the bags one at a time. The probability of damage is increased greatly when handling of every bag is necessary at each point in the system.

A well established principle of physical distribution states that proper unitization of individual packages will reduce losses. A number of alternative means of unitizing could be employed. Shrink packs on pallets with a combination of plastic and vinyl strapping is one. Containers of various other types could also be used. These alternatives need to be further investigated as to the costs and benefits. Unitization may or may not be part of a long range solution

to improving the distribution system, however in the short run it can provide quick relief to the magnitude of losses currently being sustained.

Handling and storage techniques at the warehouses throughout the system represent another major constraint. Currently, fertilizers are being stored in warehouses in ways that are likely to damage the quality. Since the majority of the fertilizer does not move to cooperative depots until very near the planting season, NAMBOARD must store a large quantity of fertilizer during the months prior to planting season. Covered warehouse space is overtaxed and some product must be moved to outdoor storage on hardstands or on t e ground. No dunnage is used to provide a cushion and airflow essential to maintaining quality.

Stacking bags of fertilizer too high is also a constraint. In some warehouses, the team observed stacks of fertilizer as many as 44 high. This results in serious compression of the bags at the bottom half of the stacks. Furthermore, no dunnage was used under the bags. This compounds the problem of damage to the fertilizer granules.

Finally, policies for rotating the fertilizer in the warehouse were not established, so that the first product into the warehouse would be the first product out of the warehouse. The probability of damage and losses occuring increases with time. Hence, the above mentioned problems are worsened by lack of proper rotation policies.

Alternatives to solve these problems require that increased attention be given to the location of the fertilizer products in the system durin each month of the year. Some stocks information was collected b the team during the course of the study. However, additional information, including the location of inventories during

each month of the year, the capacities of warehouses in the system and the percent capacity used during each month of the year would help in rationalizing the system. This type of information would make possible the avoidance of overloading NAMBOARD facilities as inventories build up for the planting season and would allow improved handling techniques to be used at NAMBOARD's main warehouse at Lusaka.

4. Transportation Timing, Availability and Cost - Transportation of fertilizer within the borders of Zambia is another major part of the system where constraints exist, as observed by the study team. The fertilizer moves by rail and truck to the NAMBOARD depots. From that point, it must be moved to the district depots owned and managed by the cooperative unions. A major cost increasing factor in the current system is the poor timing in transportation which results in delays to farmers in obtaining their fertilizer on time and at the right place.

Major constraints in the timing, availability and cost of transportation are as follows:

1) Many cooperative unions fail to purchase the fertilizer well in advance of the planting season and to transport the fertilizer to their district depots at the time that the maize is purchased and hauled out. This means that regional depots are stockpiling the fertilizer until close to planting time.

2) NAMBOARD regional depots are full of fertilizer at the peak of maize procurement time forcing any fertilizer brought in to be stockpiled outside. While typically some fertilizer is stored outside, this tends to discourage the trucks coming for maize to haul fertilizer in and maize out from the

provinces.

3) The differential in the payout for long distance hauls is such that transporter availability is tight in the provinces near Lusaka during maize hauling season. Transporters would rather move to the outlying provinces to collect maize and get the longer hauls.

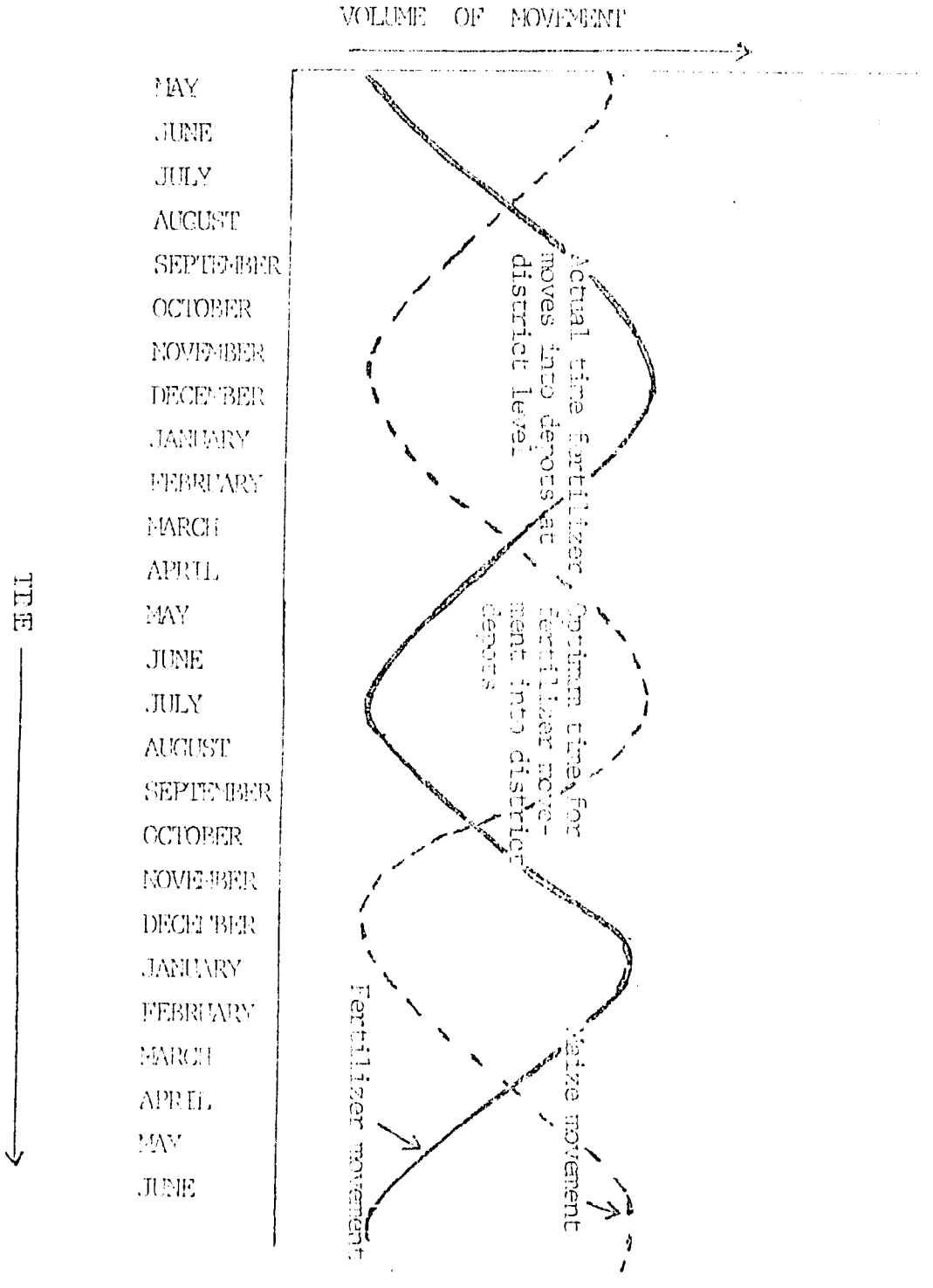
4) Storage facilities at the rural level are inadequate to maintain fertilizer quality.

5) No system for providing security for inventories exists.

The maize/fertilizer movements should ideally be less counter-cyclical to reduce transport costs and provide adequate service to farmers. The counter-cyclical nature of the current maize and fertilizer demand are shown in Figure 14. The dashed line indicates the volume of maize being marketed and requiring transport during various months of the year. The solid line indicates the amount of fertilizer that is marketed during those same months. The optimal time for transport of fertilizer into the district and rural depots is when the maize marketing is heaviest. The reasons for this being an optimum time are several. First, the fertilizer provides a payload out from the district depot. Second an additional trip to the district depot 2 to 4 months after the maize has been hauled out, can be eliminated. Thirdly, attempts to move all the fertilizer at planting time, result in late delivery to the farm. Furthermore, the rush at this time results in delivery of inappropriate product to some sales centers and damage to the fertilizer is increased by transporting after the rains have begun.

An analysis of transportation costs was conducted by the team for the Southern Province Cooperative Marketing Union. The analysis

FIGURE 14: TIMING FOR FERTILIZER AND MAIZE MARKETING AND MOVEMENT INTO DISTRICT DEPOTS FOR TRANSPORT



--------- = Maize Marketed

_____ = Fertilizer Marketed

involved determining tonnages of fertilizer movement and the distances moved from each district depot to each of approximately 400 rural depots. Costs were based on commercial rates of haulage existing at the time the data was collected.

Estimates of the transportation costs are illustrated in Table 20 on the basis of cost per ton delivered, while Table 21 expresses the costs in terms of costs per bag of fertilizer delivered. A marked difference should be noted for the costs of delivery among the various districts. The average cost of delivery per ton of fertilizer delivered to a rural depot varied from a high of K15 in Namwala district to a low of K4 in Monze and Mazabuka districts. In general, the average costs of transporting a ton of fertilizer to the rural depots was less than K5 per ton. Namwala and Kalomo were exceptions to this, due to the greater distances between the district depots and the rural depots. The average distances from district to rural depots is shown in Table 22.

Transportation cost for the entire province was estimated at K370,000 to move over 64,000 metric tons of fertilizer. The costs could be significantly reduced if fertilizer could be moved to the rural depots at the time trucks are dispatched to gather maize. To make this possible secure and appropriate covered sheds for fertilizer storage should be built at the rural depots.

Some cooperative managers indicated to the team that a major reason for late shipments to district depots is the failure of NAMBOARD to have the correct fertilizer stocked in the regional depots when maize is moving. While this may be true in some instances, the team observed NAMBOARD facilities full of fertilizer during the peak of the maize procurement season.

Table 20

SOUTHERN PROVINCE FERTILIZER AVERAGE AND TOTAL TRANSPORT COSTS BY DISTRICT

DISTRICT	TONS	TOTAL COST	AVERAGE COST
Choma	15170.3	66255.84	4.367
Namwala	4530	69294.49	15.297
Pemba	2230	12584.96	5.643
Kalomo	14115	114989.8	9.693
Livingstone	3450	10812.89	3.125
Mazabuka	14030	53233.86	4.11
Monze	10360	42574.84	4.109
Province Total	63895.3	369746.7	5.786759

Table 21

SOUTHERN PROVINCE FERTILIZER TRANSPORT COSTS BY DISTRICT

DISTRICT	BAGS	TOTAL COST	AVERAGE COST
Choma	303406	66255.84	.21
Namwala	90600	69294.49	.76
Pemba	44600	12584.96	.28
Kalomo	282300	114989.8	.41
Livingstone	69200	10812.89	.16
Mazabuka	280600	53233.86	.19
Monze	207200	42574.84	.21
Province Total	1277906	369746.7	.29

TABLE - 22

SOUTHERN PROVINCE FERTILIZER TRANSPORT MILEAGE TO RURAL DEPOTS BY DISTRICT

	Average Distance to Depot (Km.)
Choma	45.3
Namwala	137.2
Pemba	37.9
Kalomo	64.7
Livingstone	46.6
Mazabuka	48.9
Monze	32.5
Province Average	59.01

A frequent explanation for the failure of unions to purchase fertilizer is the lack of adequate operating capital to finance both maize and fertilizer at the same time. Perhaps there is also the unwillingness of the unions to incurr the added interest cost to finance these inventories, since the fertilizer cannot be marked up in price to cover the added costs. There is simply no incentive to move fertilizer to district and rural depots much before planting time.

Several alternatives need to be examined. One of the sources of the shortage of working capital is the delays in restitution payments from the Government. Earlier payment of restitutions would free up capital for maize and fertilizer purchases.

A second alternative would be the extension of credit by NAMBOARD for inventory of fertilizer when it is purchased early by the unions. The team found a reluctance by NAMBOARD to comply with this alternative due to fear that repayment would not be made promptly by some of the unions. Although NAMBOARD must currently finance and hold the inventories, they can be more sure of payment under the current cash and carry arrangement.

A third alternative is the barter of grain purchased from NAMBOARD by the unions. This arrangement has the added benefit of reducing bank charges for loans issued under the present system of cash buying for fertilizer and maize.

The third constraint was the availability of fertilizer transporters in the provinces near Lusaka. Transport operators prefer the longer hauls to outlying provinces to the short hauls even though the rates for short hauls are higher. This creates shortages transportation shortages in provinces like Central Province. Current transport rates are listed in Table 23.

Table 23 - COMPARISON OF TRUCK TARIFFS

DISTANCE (Kms.)	CURRENT RATES	TRANSPORTER REQUEST	UNION OFFER	PERCENT TARRIF
0-80	.16/Km.	.30/Km.	.26/Km.	163%
80-160	.12/Km.	.25/Km.	.18/Km.	150%
160+	.10/Km.	.20/Km.	.12/Km.	120%

The first column shows the current rates, the second shows the rates requested by transporters and the third shows the tariff currently offered by Central Province Cooperative Marketing Union to attract transporters.This seems to be the most viable alternative for solution of the long haul bias of transporters. Without a premium, transporters will naturally try to maximize their net revenue.

4. Constraints in Order and Dispatch Flows from Port to NAMBOARD - The main constraints discovered by the study team are:

1) A freight forewarder has to be used to consign shipments to the proper NAMBOARD warehouse.
2) The amount of direct shipping of fertilizer is limited by the failure of the cooperative unions to purchase prior to planting season from the regional NAMBOARD warehouses.
3) The amount of direct shipping to cooperative district warehouses is limited to those served by rail and good roads.

The first constraint is a problem of coordination that is created when a freight forewarder must be involved in the information flows of orders and dispatching within the system. Using this extra link in the flow of information is preferable to transhipping all further fertilizers through the Lusaka Main depot. However, it would make the system operate more smoothly if the forewarder could be eliminated from

order dispatch cycle.

The first alternative would involve receiving the fertilizer shipment CIF Livingstone or some other point in Zambia. This fertilizer could then be dispatched by NAMBOARD to the proper location in Zambia.

Alternatively, NAMBOARD personnel could perform the entire forewarding function themselves. Of the two alternatives this seems to be the less attractive, because of the personnel involved potentially being idle a large amount of time. Further evaluation of these alternatives is recommended.

The second constraint involves being able to move the product to the cooperatives soon enough. It is desirable to have most of the volume currently handled by the regional NAMBOARD warehouses move directly to those warehouses from the port. Backups of fertilizer movement at the regional level because it cannot move on to the cooperatives, means that much fertilizer has to be shipped first to Lusaka and then on to the regional depots at a later date.

Alternatives for this constraint lie outside the NAMBOARD structure. The answer lies in providing cooperatives adequate incentive to purchase and move fertilizer from the regional depots earlier in the season. This in turn would require improved storage at the cooperatives and means of financing the fertilizer inventories at the cooperative unions. The relative costs of moving inventories through warehouse rentals or price incentives need further research.

The third constraint is the rail and road system over which the fertilizer must travel. Improving this infrastructure requires decisions outside the current distribution system.

The best solution to the constraints in the ordering and

dispatching of fertilizer is improved coordination of NAMBOARD shipments and cooperative purchases, so that inventory is moved to the rural depots at the earliest possible opportunity.

5. Constraints in Order and Dispatch Flows between NAMBOARD and the Cooperatives - Major constraints observed are:

1) Sales personnel in rural depots are not adequately trained to perform the task of placing orders for the fertilizer products they handle.
2) Farmers' orders do not trigger the flow of product through the cooperative system. Instead, fertilizer moves at the order of the provincial cooperative union.
3) The order system does not guide inventory far enough into the system early in the season.
4) There is no accurate flow of inventory information among those who use fertilizer, the rural depot managers and NAMBOARD.

There is need for a well trained sales force at the rural depot level. It is the judgement of team from observations made, that the personnel who sell fertilizer to the farmer have little knowledge about the use of fertilizer, the properties of different fertilizers and the substitutability of different fertilizers. This lack of knowledge is accompanied by lack of skill in evaluating the trade territory and its fertilizer needs.

As a result the initiation of orders from the rural sales center through the system is not practicable at this time. These tasks are thus left to the cooperative unions at the district and provincial levels. Differences in needs of local producers in various parts of the province are impossible to evaluate at this higher level.

Customer demand does not trigger the order process and this is another serious constraint. Farmers interviewed by the team stated that no fertilizer was available and complained of fertilizer arriving late and the stocking of the wrong fertilizers at the time needed. This situation is symptomatic of a system that does not properly communicate customer demand through orders originating at the rural depot level and passing upward through the system.

Alternatives for elimination of this constraint would require that the sales force be well trained. Orders reflecting customer needs could then originate at the local level.

The current order system is performing poorly in guiding fertilizer to inventory nodes close to the producer (the local rural depot) early in the season. Local unions do not now receive the fertilizer in stock early enough to mount any kind of an effective sales program. One of the existing reasons is of course the lack of adequate storage as previously mentioned. Building adequate storage will help.

The team observed that the demand information passing between the cooperatives and NAMBOARD is very inadequate and often not accurate. This is partly due to problems outlined above. In addition NAMBOARD no longer has a means of determining directly how well actual farmer needs are being met at the rural sales points, i.e. in terms of appropriate products and their availability and timely delivery. This information is needed by some alternative means since the present order system cannot provide it.

The team interviewed farmers who believed inaccurately that the fertilizer was not available because NAMBOARD did not have fertilizer stocks in the regional warehouse. At the same time, the regional

warehouses were full of fertilizer and it was being stored on the ground. In the absence of an order system which effectively communicates customer needs, some type of communication mechanism needs to be established between producers in the provinces and NAMBOARD. The flow of information will continue to be disjointed and inaccurate if the wholesale and procurement activities in the system are not guided by accurate information from the users of the fertilizers, the farmers. Furthermore, NAMBOARD needs some mechanism for informing farmers directly about fertilizer use and product characteristics. Information needs to flow smoothly in both directions and the cooperatives are often failing to provide the needed link between NAMBOARD and the producer/farmer.

IX. FERTILIZER PRICING

The price of fertilizer in Zambia is an administered price and as such is a very important instrument in effecting government policy. This section reviews (1) the purpose or function of prices in the system, (2) the pricing process, (3) historical information on prices and (4) two major aspects of fertilizer pricing which influence the performance of the marketing and supply of fertilizer and its use.

A. PURPOSE OF PRICES

Price is one of the most important policy instruments available for regulating scarce resource use and for rationing available supplies of a commodity like fertilizer. Price affects the availability of fertilizer supplies and influences how much fertilizer will be demanded for crop production.

In the Zambian context, fertilizer price has historically reflected the desire of the Government to stimulate food production on the one hand without unduely increasing costs of food to consumers on the other. The fertilizer price also reflects Zambia's choice to invest heavily in the development of its own fertilizer production at Nitrogen Chemicals of Zambia Ltd. Government subsidies to the producers, users and ultimate beneficiaries of fertilizer use have therefore been a heavy burden on the Zambian economy, a burden which has had to be re-evaluated in the recent economic situation.

Fertilizer price should also provide adequate incentive to move fertilizer efficiently through the distribution system. This aspect of fertilizer pricing will be analyzed later.

B. THE PRICING PROCESS

The price producers pay for fertilizer products is set by the the Planning Division of the Ministry of Agriculture and Water Development in consultation with NAMBOARD, the Ministry of Finance, Commercial Farmers Bureau and other concerned institutions. The Cabinet provides the final approval for the newly established prices after a lengthy process of review has been completed. These approved prices, when they go into effect, will be administered uniformly at all the distribution centers throughout the distribution system.

Price determination involves several steps and takes a number of factors into account amoung which are the following:

1. The national fertilizer requirements are estimated by the National Fertilizer Committee.
2. The quantities to be produced by NCZ and those to be imported are made known.
3. The costs of imported and locally produced fertilizer are calculated and an average cost per ton determined.
4. The Ministry of Finance indicates how much is available for handling, transportation and price differential subsidies.
5. MAWD then works out the selling price of fertilizer on the basis of what is available for subsidy.

In 1983, fertilizer price determination also took into account the 20% devaluation of the Kwacha and the additional costs to be incurred by NAMBOARD, due to cutting down on the proportion of imports in favor of increasing purchases of locally produced fertilizer from Nitrogen Chemicals of Zambia, Ltd.

C. HISTORICAL PRICE INFORMATION

Table 24 shows producer fertilizer prices for the various fertilizer products being retailed in Zambia from 1977 to the present. The prices of the more popular fertilizers have gone up 268 per cent in the last 7 years. The largest single increase in price came in May of 1983. In fact, looking at the prices of Compound "D", the change in price from July of 1982 (K183) exceeds the entire increase in price from 1977 to 1982. As mentioned above, this reflects several policy decisions including devaluation and increased support for NCZ. During this same period, the producer price of maize increased from K6.8 per 90 Kg. bag to K21.50, an increase of 209 per cent (Table 25). Typically, the cost of fertilizer has been figured into the projected costs of production budgets which form the basis for the gazetted producer crop prices. However, in the latest gazetted prices, the price of maize increased only 14 per cent while the price of fertilizer increased by more than 50 percent. The impact of these shifts in price relationships will be looked at further below.

The rationing function of price does not seem to have had much of a dampening impact on the consumption of fertilizer. As was mentioned earlier, fertilizer has had an annual increase of approximately 8 per cent or about 58 per cent from 1977 to 1983. The recent stiff increases in price could well have a substantial impact on fertilizer demand in the 1983-84 season.

Subsidies were initially introduced to encourage fertilizer use by all farmers, especially the small farm sector, to stimulate increased food production. The direct price subsidies took two forms. First there was a price differential subsidy, to reimburse NAMBOARD and its

TABLE 3: FERTILIZER PRICES - 1977/78 TO 1 MAY 1983

Fertilizer Type	1977/78	1978/79	From 13 Aug 79 To 31 May 80	1 June 80 To 30 June 81	1 July 81 To 29 July 82	30 July 1982	1 May 1983
			Kwacha Per Metric Ton				
A	140.00	140.00	180.00	140.00	183.00	263.00	446.00
C	135.00	175.00	220.00	180.00	223.00	293.00	446.00
V	120.00	120.00	200.00	160.00	203.00	283.00	466.00
R	120.00	176.00	235.80	195.00	238.80	299.00	482.00
X	134.00	174.00	235.80	195.80	238.80	299.00	482.00
D	131.00	171.00	232.00	192.00	235.00	299.00	482.00
AN	120.00	156.00	221.60	181.60	212.00	281.60	464.00
AS	96.00	124.00	185.00	145.00	188.00	268.00	451.00
Urea	135.00	175.00	233.00	193.00	219.00	299.00	482.00
SN	140.00	161.00	264.00	224.00	267.00	327.00	510.00
SSP	90.00	117.00	124.00	144.00	187.00	267.00	450.00
TSP	129.99	167.00	270.00	230.00	273.00	333.00	516.00
MOP	72.00	72.00	96.00	95.00	139.00	219.00	422.00
SOP	84.00	84.00	111.00	111.00	154.00	234.00	417.00
Mixed TSP & SSP	-	-	-	-	-	-	487.00
Mixed & Lumpy	NA	140.00	NA	120.00	163.00	324.00	426.00
Wet Fertilizer	NA	120.00	NA	100.00	143.00	223.00	406.00
Gypsum	42.00	NA	NA	NA	NA	178.00	NA
Solubor	400.00	NA	NA	NA	NA	NA	NA
Sweepings	NA	NA	NA	140.00	183.00	262.00	445.00

NA:- NOT APPLICABLE

SOURCE:- Annual Agricultural Statistical Bull 1981. Central Statistics Office 11/82 and NAMB 3 May 1983.

Table 25 AGRICULTURAL PRODUCER PRICES IN ZAMBIA, 1976-1984

	UNIT	1976	1977	1978	1979	1980
	KWACHA					
Maize (a)	90Kg Bag	6.30	6.80	9.00	9.00	11.70
Groundnuts (b)	80Kg Bag	25.00	28.60	32.00	32.00	35.00
Sunflower	50Kg Bag	10.00	12.50	13.70	13.70	16.40
Soyabeans	90Kg Bag	17.00	21.50	25.50	33.00	33.00
Wheat	90Kg Bag	16.00	18.00	20.00	20.00	24.00
Milk	Litre	0.18	0.20	0.21	0.25	0.25
Paddy Rice	90Kg Bag	16.20	16.20	18.00	18.00	15.00
Tobacco, Virginia (c)	Kg	1.04	1.45	1.45	1.51	1.57
Seed Cotton (d)	Kg	0.40	0.46	0.46	0.46	0.46

	UNIT	1981	1982	1983	1984
	KWACHA				
Maize (a)	90Kg Bag	13.50	16.00	18.30	21.50
Groundnuts (b)	80Kg Bag	46.05	48.00	55.00	71.00
Sunflower	50Kg Bag	17.60	20.75	21.50	-
Soyabeans	90Kg Bag	36.30	42.21	45.30	52.50
Wheat	90Kg Bag	26.00	32.00	35.75	42.50
Milk	Litre	0.36	0.43	0.47	0.52
Paddy Rice	90Kg Bag	18.60	23.00	40.00	-
Tobacco, Virginia (c)	Kg	1.65	2.40	2.70	2.30
Seed Cotton (d)	Kg	0.46	0.47	0.52	0.58

SOURCE: Central Statistical Office and Ministry Agriculture and Water Development.

NOTE: Year indicates end of Harvesting Seasons, e.g. 1981/82 = 1982.

agents for retailing fertilizer at a price lower than the average of the imported and locally produced product. Then, because of the policy of uniform pricing, there was a handling and transportation subsidy rather than differentiate price on the basis of distances fertilizer had to travel. Thus the farmer purchased fertilizer at a price which reflected neither the total cost of production and procurement nor the cost of transportation. There also have been indirect forms of price subsidy, eg. subsidized credit for fertilizer inputs.

The impact of these price subsidies has not been equal among all farm populations. Those who have benefitted the most have been those who produce and sell the most of their production, namely the large scale commercial farmers. The uniform nature of the price favors the more remote producers compared to those for whom transportation costs are much less. These subsidies have put a substantial financial load on the GRZ budget.

These subsidies like many others were reduced substantially with the belt tightening measures instituted by the Government to put the economy on a sounder financial footing.

D. CONSTRAINTS IN THE CURRENT PRICING SYSTEM

Two major constraints were identified by the study team which are a result of the current pricing system. The first is the negative impact the current uniform pricing structure has on incentive to move fertilizer efficiently and effectively through the distribution system. The second problem area is the impact of prices on the use of fertilizer by the small scale producers.

Prices should be structured in such a way as to provide incentive to the marketing and supply system to move fertilizer efficiently through the system in a timely fashion. The current fixed and

uniformly administered pricing structure does not reflect any of the value added by various activities as the fertilizer moves through the system. Likewise, there is no means of determining whether or not a given portion of the distribution system is performing well without comparing the value added at that point in the system with the cost generated there. Receiving a rebate for costs incurred, and receiving that at a date long after the costs are incurred is a disincentive to the rapid and effective movement of fertilizer.

This problem is particularly evident as it pertains to the price paid by the cooperative unions for fertilizer and what they are allowed to charge the farmer. Charging the farmer the same price as was paid for the fertilizer will encourage inefficiency and poor performance. Under this system, the unions have every incentive to minimize costs by delaying purchase and movement of fertilizer until the latest possible time. This strategy reduces holding inventory, maintenance of storage facilities and acceptance of the financial responsibility for the product. The restitution payment will be the same, no matter when the move the product. The system forces the movement of fertilizer at a non-optimal time. The resulting delays in the arrival of fertilizer can be very costly in decreased farmers' yields.

The team observed large stocks of out-of-condition fertilizer, some of which had been taking up valuable storage for years. There is no good method of pricing at present to provide an incentive to move this product out where it can be used before it deteriorates further.

The study team recommends the establishment of a system of internal transfer prices for product moving from port through the distribution system to final sale at the rural depot to measure the value added at each stage. The price to final user should reflect this

value added along the way. Both NAMBOARD and the cooperatives should be allowed to charge enough more for fertilizer to their customers to reflect the value added by their services. There should also be a price differential reflecting the storage costs, such that fertilizer would cost less for early purchase. Prices should be increased as the season progresses. This should provide increased incentive to move product through the system in a timely fashion. If subsidies are needed in the rural area to encourage fertilizer use, particularly among small scale farmers, there are more effective forms of subsidy, which can be selectively administered, than the pricing structure.

Farmer response to subsidized fertilizer prices was to demand more fertilizer than could be supplied at the prices being charged. In some cases the policy has led to application rates of fertilizer which are higher than would be economically justified. The price difference between Zambia and neighboring countries could at times have encouraged the movement of fertilizer across borders for resale. The team did not observe this phenomenon, but the incentive was undoubtedly there. The present policy of pricing at nearer the actual cost should deter this form of activity.

During a number of interviews with farmers, Extension staff and researchers on adaptive research planning teams, the issue of the large increase in fertilizer price relative to the increase in maize was raised for discussion. There was a general feeling that the new fertilizer prices will discourage some small farmers from using fertilizer.

Members of the Adaptive Research Planning Team in Eastern Province stated that some farmers who are just now beginning to produce a portion of their maize for the cash market have very low annual income

levels and low total levels of family assets. The expenditure for fertilizer represents a large portion of their annual income and assets. Hence, an increase in fertilizer price of this magnitude increases their financial risks of production . This risk is larger both in relation to their total family assets and and their annual income. The ARPT team concluded that for these farmers, the price increase means reduced use of fertilizer.

In general, it can be concluded that the higher relative prices of fertilizer to maize may shift some resources into to the production of other crops which require less fertilizer than maize and have a higher net return per hectare. Those farmers with low yield levels of maize in particular will probably find the increased cost of production prohibitive and will exit maize production to something more profitable. Those with high yield levels will find that maize production is still a very profitable enterprise despite the sharp increases in fertilizer prices.

As Table 26 and Table 27 demonstrate, the more efficient producers with good yields will actually be better off with the new combination of maize price and fertilizer prices than they were last year. These tables were developed from an actual farm budget worked out at the Lundazi Rural Reconstruction Center using 1982 costs of inputs and price of maize. The second table uses the same inputs, changing only the price of fertilizer and maize to reflect the new price to be received. Then, at the bottom of each table is a sensitivity analysis of varying yields. The exercise simply supports the above assertion that the farmers with low yields and relatively high costs will likely be shoved toward changing to other enterprises than maize. Or conversely, there is an increased incentive towards

TABLE 26- LUNDAZI RURAL RECONSTRUCTION CENTER
MAIZE BUDGET (100 Ha.) - 1982

Item	Amount Per Hectare	K/Unit	Cost/Ha.
Seed	20 Kg. SR-52	1.04	20.80
Fertilizer	4 Bags D-Compound	24.10	96.40
	4 Bags Urea	24.10	96.40
Herbicide	4 Litres Primagram	10.45	41.80
Tractor			
Ploughing	4 Tractor Hours	16.50	66.00
Harrowing	2 Tractor Hours	8.25	16.50
Planting	2 Tractor Hours	8.25	16.50
Hired Labor	30 Man-days	2.18	65.40
Bags and Twine		3.60	3.60
Transport to and from Depot, etc.		45.00	45.00
Miscellaneous 10% of Variable Cost (468.40 X .10)			46.84
Interest on Variable Costs (515.24 X .12)			61.83
	Total Variable Costs Per Hectare		K577.07

Gross Margin	
Expected Yield - 40 Bags @ K21.50	860.00
Minus Total Variable Costs	-577.07
Gross Margin Per Hectare	K282.93
Gross Margin Per 100 Hectares	K28293.00

GROSS MARGIN PER HECTARE

Y	20	-147.10
I	25	- 39.57
E	30	67.93
L	35	175.43
D	40	282.93
	45	390.43
	50	497.93

TABLE 27 - LUNDAZI RURAL RECONSTRUCTION CENTER
MAIZE BUDGET (100 Ha.) - 1982

Item	Amount Per Hectare	K/Unit	Cost/Ha.
Seed	20 Kg. SR-52	1.04	20.80
Fertilizer	4 Bags D-Compound	14.95	59.80
	4 Bags Urea	14.95	59.80
Herbicide	4 Litres Primagram	10.45	41.80
Tractor			
Ploughing	4 Tractor Hours	16.50	66.00
Harrowing	2 Tractor Hours	8.25	16.50
Planting	2 Tractor Hours	8.25	16.50
Hired Labor	30 Man-days	2.18	65.40
Bags and Twine		3.60	3.60
Transport to and from Depot, Etc.		45.00	45.00
Miscellaneous 10% of Variable Cost (395.20 X .10)			39.52
Interest on Variable Costs (434.72 X .12)			52.17
Total Variable Costs Per Hectare			K486.89
Gross Margin			
Expected Yield - 40 Bags @ K18.30			732.00
Minus Total Variable Costs			-486.89
Gross Margin Per Hectare			K245.11
Gross Margin Per 100 Hectares			K24511.00

GROSS MARGIN PER HECTARE

Y	20	-120.90
I	25	- 29.39
E	30	62.11
L	35	153.61
D	40	245.11
	45	336.61
	50	428.11

higher yields and improved efficiency with the new price relationships.

Fertilizer use must be combined with good management practices to provide yield levels high enough for economic viability of the enterprise. There is need for other developmental programs for those farmers just beginning to understand the value of fertilizer use and whose resources limit their capacity to stand the increased risk associated with its use at current prices.

A. AGRONOMIC RESEARCH AND RECOMMENDATIONS

Research on crop response to fertilizers is conducted at 21 stations and trial sites located in all regions (Figure 1). They are located on the major soil and agricultural production areas of Zambia.

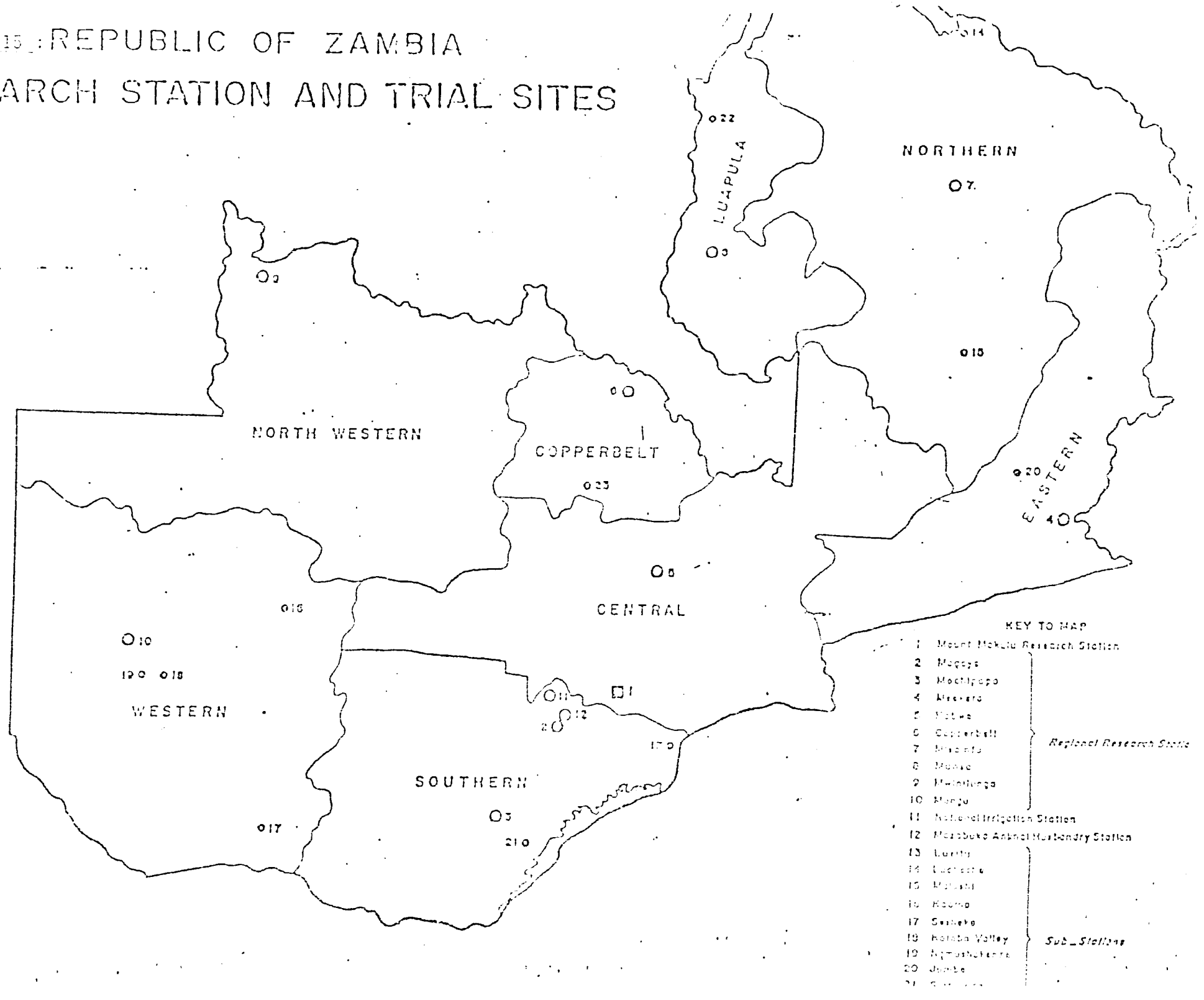
NAMBoard and the cooperatives, the organizations physically distributing fertilizers, do not carry out or contribute to any soils, fertilizer or crop response research. However, a great deal of research has been undertaken over the last 20-odd years by the Ministry of Agriculture and Water Development Department of Agriculture Research Branch to identify the nutrients that must be applied for various crop yields are well ahead of most developing countries in Africa.

Ultimately the fertilizer marketing organization must augment the efforts of the Research and Extension staff in establishing site-specific crop response data and provide feed-back to research organizations the data and problems so that solutions can be found. A well-developed marketing organization will verify fertilizer recommendations and use positive results to promote proper fertilizer use.

Responses to nitrogen, phosphoruous, potasium and lime could be expected on Zambian soils and were found. What is surprising is the need for sulfur and its recommendation for all soil and crop conditions in Zambia. Certainly the soils are low in organic matter (average 1) and the N:S ratio within a crop such as maize is 10:1, but to find that all soils and crop conditions require a basal drsssing of 20 to 40 Kgs/ha/year is surprising.

FIGURE 15 : REPUBLIC OF ZAMBIA

RESEARCH STATION AND TRIAL SITES



Responses to sulfur-fertilizer in Zambia is documented by J.B.M. Vogt in Agrochemica X in 1966. He obtained increases of 500% by the addition of 25 Kg/ha of flowers of sulfur with urea or CAN using maize as the test crop. Rates above 10Kgs/ha gave marginal increases in yield. Response of maize to sulfur application was directly related to the amount of nitrogen applied. He suggested the possibility of using urea and sulfur fused together in the proper ratio. In the light textured soils of Zambia, sulfur-coated urea, as developed by TVA and IFDC, may well provide a timed release of nitrogen, a reduction in nitrogen loss and be more economically produced in Zambia than the current compounds. The use of sulfur should be limited as much as possible because the acid it produces increases the depletion of all other nutrients and lowers the soil pH to the point where aluminium toxicity becomes a serious problem.

The extent of the sulfur deficiency is shown in Table 28. While these early data may be subject to a coefficient of variation of 20% on the observation on trials (Table 29) they point up considerable variation in sulfur response of maize ad diverse sites in Zambia.

At Serenje, Kecmbe, Namushakende and Ngoni maize did not respond to sulfur application. In simple observation trials the addition of sulfur to urea increased yields in some cases by more than 500% (Table 29). Sulfur deficiency is severe in Luapula, Northern and Eastern Provinces. The Kalahari sands in the West and the sandveld soils of Southern Province are no doubt deficient in sulfur.

Research on the maize production at the Kabwe Regional Research Station for the past 12 years show very little response to either potasium or sulfur. The lack of sulfur response may be due to air pollution around station.

TABLE .28.. Yield Response of Maize to Applications of Nitrogen and Sulfur to Various Soils in Zambia.

Location	Control	No.	N*+S*	S**
	Kg/ha			
Mankoya	1183	1704	2444	1188
Mungwi	336	1009	2466	381
Mpika	1973	2421	4103	2444
Lundazi	1390	1502	4731	2713
Msekera	740	1368	2197	919
Serenje	673	1502	1166	650
Keembe	1995	2735	2533	1995
Mamushakende	6412	7511	7623	7668
Ngoni (1961-62)	493	2107	1973	1323
Ngoni (1962-63)	740	4125	3856	695

* Mean of 67.3 and 134.5 KgN/ha applied as Urea and CAN.

** Mean of 80.7 and 161.4 KgS/ha applied as flowers of Sulfur

Source: Vogt, J.B.M., Agrochemica X, No. 2, 1966.

Table 29. Yields of Maize to Applications of Sulfur on Observation Trials with Urea to various Soils in Zambia

Location	Control	Urea*	Urea* + S*
	Kg/ha		
Malashi (6)	942	1009	3811
Chisanga (3)	1345	830	3946
Mpika Station	1188	2063	2915
Luwingu	1188	874	5112
Old Fife (3)	2063	1995	3094
Kalichero	874	1054	5358
Lundazi	381	740	4103

* Urea applied at 300 Kg/ha

** Sulfur applied at 157 Kg/ha

Source: Vogt, J.B.M. Agrochemica X, No. 2, 1966

The response of maize to applications of nitrogen at this site are as follows: (12 year mean)

Nitrogen Applied (Kg/ha)	Maize Yield (Kg/ha)
79	5201
135	5488
191	5858

An application of 20Kg P_2O_5/ha increased yields from 4974 Kg/ha to 6882 Kg/ha (12 year mean). An application of 9Kg/ha of K_2O increase the mean maize yield from 5385 Kg/ha to 5635 Kg/ha. There appears to be a gradual decrease in maize yields over the 12 year span.

Fertilizer response curves for the various soils and crops, either have not been obtained or are very private information. In view of the fact that they have not been published, an intensive program to obatin this essential data for each nutrient should be be initiated immediately. Further, an interest in soil testing is emerging. For such a program to be valid, correlation of soil test levels with nutrient applications and crop yield response is mandatory. Crop response to increasing rates of application of each nutrient singly and in combination on farmer's fields forms the basis of economic planning by the farmer and any national agency. The value: cost ratio and the net return provide the basis for recommendations of fertilizer applications rates, fertilizer prices and crop support prices. Procedures for this research was presented at the FAO/NORAD Seminar on Fertilizer Use Development in December, 1976. To expedite the acquisition of this data, a coordinated effort by research, extension and the marketing organizations should be initiated.

FERTILIZER RECOMMENDATIONS:

Fertilizer and lime recommendations are published by the Research Branch of the Department of Agriculture on Advisory Sheets. These recommendations consider three levels of soil fertility for nitrogen, phosphate and potash as listed below:

Nitrogen:

Low	:	Early plowed or renovated lands or grassleys
Medium	:	Early plowed virgin or reverted lands and grassleys
High	:	Following a good leguminous crop. Lands which leave received heavy dressing of manure or compost.

Phosphate:

Low	:	P test value below 7
Medium	:	P test values 7 - 15
High	:	P test values above 15

Potash:

Low	:	K test values below 0.15
Medium	:	K test values 0.15 - 0.40
High	:	K test values above 0.40

Lime:

Slightly Acid	:	pH 5.5 - 6.0 - Lime not needed
Medium Acid	:	pH 5.0 - 5.5 - Satisfactory for most crops
Strongly Acid	:	pH 4.5 - 5.0 - Maintenance application necessary
Very Strong Acid	:	Below pH 4.5 - Remedial Liming essential

The Advisory Sheets consider: Varieties, seeding rate, plant population, depth time of planting, pest control, weed control, harvest and storage conditions, and expected yield. Cited below for each crop are the nutrient requirements for each fertility status, the critical lime levels and the fertilizer application rates.

Table 30

FERTILIZER MIXTURES:

Based upon the research, five fertilizer mixtures are made available to farmers in Zambia. The percentage composition is shown below together with the commonly used nitrogen fertilizers:

Mixture:	N	P_2O_5	K_2O	B	S
C*	6	18	12	0.1	10
V*	4	18	15	0.1	10
R	20	20	0	-	10
X	20	10	5	-	10
D	10	20	10	-	10
AS	21	-	-	-	24
Urea	46	-	-	-	-
AN	34	-	-	-	-

* From potassium sulfate for tobacco

The need for lime is well established. Relatively low rates of application are required. (Lime is discussed separately later). The recommended amounts of these fertilizer products and lime is shown below.

MAIZE

Table 31

Fertility Status	NUTRIENT REQUIREMENT N	P_2O_5	K_2O	S
	KG/HA			
Low	160-180	70-90	30-40	20 min
Medium	120-140	40-60	10-20	20 min
High	80-100	20-30	0	20 min

Apply as from 200-300 "X" or 'R' plus 200-300 AN Kg/ha to 300-400 "D" or 'R' plus 200-400 Urea Kg/ha.

Apply Lime as follows:

Soil Texture	Critical pH	Maintenance Lime Requirements (kg/ha)
Sands	4.4	500-1000
Sandy loams	4.6	1000-1500
Sandy Clays	4.8	1500-2000

IRRIGATED WHEAT

Fertility Status	NUTRIENT REQUIREMENT N	P_2O_5	K_2O	S
	KG/HA			
Low	120-140	70-90	30-40	20 min
Medium	100-110	40-60	10-20	20 min
High	70-90	20-30	0	20 min

Apply as 250 "C" plus 250 Urea kg/ha

Apply Lime as follows:

Soil Texture	Critical pH	Maintenance Lime Requirement (kg/ha)
Sands	4.6	500-1000
Sandy Loams	4.8	1000-1500
Sandy Clays	5.0	1500-2000

RICE

Table 31 (cont.)

Fertility Status	NUTRIENT REQUIREMENT			
	N	P_2O_5	K_2O	S
	KG/HA			
Low	70-90	100-120	30-40	20 min
Medium	50-60	70-90	10-20	20 min
High	30-40	40-60	0	20 min

Apply as 200-300 "D" + 100 AN (Topdress) kg/ha

Apply Lime as follows: Not specifically recommended

SOYBEAN

Fertility Status	NUTRIENT REQUIREMENT			
	N*	P_2O_5	K_2O	S
	KG/HA			
Low	20-30	70-90	39-40	20 min
Medium	10-15	40-60	10-20	20 min
High	0	20-30	0	20 min

*Plus inoculum

Apply on rotated lands using inoculum: 200-300 kg/ha "D"

Apply Lime as follows:

Soil Texture	Critical pH	Maintenance Lime Requirement (kg/ha)
Sands	4.6	500-1000
Sandy Loams	4.8	1000-1500
Sandy Clays	5.0	1500-2000

GROUNDNUTS

Table 31 (cont)

Low fertility sites - 200-300 kg/ha "D" or SSP

Otherwise: None when grown after a fertilized crop.

Apply Lime the same as for soybean above.

SUNFLOWER

Fertility Status	NUTRIENT REQUIREMENT			
	N	P_2O_5	K_2O	S
	KG/HA			
Low	60-80	70-90	30-40	20 min
Medium	30-50	40-60	10-20	20 min
High	0-20	20-30	0	20 min

Apply on the average 200-300 kg/ha + nitrogen for Hybrids

Apply Lime the same as for Maize cited above.

COTTON

Fertility Status	NUTRIENT REQUIREMENT			
	N	P_2O_5	K_2O	S
	KG/HA			
Low	70-100*	70-90	30-40	20 min
Medium	40-60	40-60	10-20	20 min
High	20-30	20-30	0	20 min

*Nitrogen levels above 60 kgN/ha should always be confirmed by Specialist staff.

Apply on Sandy clay, rotated land as Basal 200-300kg/ha "X", or "R" or Basal 200-300kg/ha "D" + 100 kg/ha UREA

Apply Lime the same as for Soybeans cited above.

Apply Boron as Solubor (20 B) at 5 - 10kg/ha for all soil types.

BEANS

Table 31 (cont.)

Fertility Status	NUTRIENT REQUIREMENT			
	N	P_2O_5	K_2O	S
	KG/HA			
Low	100-120	60-80	30-40	20 min
Medium	70-90	40-50	10-20	20 min
High	40-60	20-30	0	20 min

Apply as 200-300 kg/ha "D" plus 100 kg/ha AN

Apply Lime as for Soybean cited above.

WARE POTATOES

Fertility Status	NUTRIENT REQUIREMENT			
	N	P_2O_5	K_2O	S
	KG/HA			
Low	130-140	190-240	100-120	20 min
Medium	110-120	150-180	60-90	20 min
High	80-100	100-140	0-50	20 min

Apply for Irrigated crop:

Basal 1200 kg/ha D plus 150 kg/ha AN at first ridging

Apply for rain crop:

Basal 800 kg/ha D plus 100 kg/ha AN at first ridging

Apply Lime as follows:

Soil Te ture	Critical pH	Maintenance Lime Requirement
Sands	4.3	500-1000
Sandy loams	4.5	1000-1500
Sandy clays	4.7	1000-1500

LUCERNE

Table 31 (cont.)

Fertility Status	NUTRIENT REQUIREMENT			
	N*	P_2O_5	K2O	S
	Kg/ha			
Low	20-30	100-120	40-60	20 min
Medium	10-30	80-90	20-40	20 min
High	0	50-70	0-15	20 min

*Plus inoculum

Apply as an average at planting 600 kg/ha "A" mixture

Annual maintenance 200-300 kg/ha SSP plus 0-100 SOP plus 20-30 kg/ha Solubor

Apply Lime as for Soybean cited above.

An expected crop response to these recommendations are shown in table 32. After five to six years these responses can be attained only if lime applications are made.

Table 32 Expected Crop Response to Recommended Fertilizer Rates

Crop	Traditional (No Fertilizer)	Improved (Small and Medium Scale)	Commercial (Large Scale)	Top Commercial
	(kg/ha)			
Maize	900	3,600	6,000	8,000
Cotton	500	1,500	2,000	2,500
Groundnuts	500	1,000	1,600	3,000
Tobacco (flue and air-cured)	500	1,000	1,500	2,000
Beans	200	600	1,000	1,500
Soybeans	500	1,500	2,000	2,500
Rice	800	1,600	2,500	4,000
Wheat (irrigated)	-	2,000	4,000	6,000
Sunflower	200	800	1,000	1,200

a. Response can vary by ± 20% according to area.

b. New varieties are showing more promise

Note: Top commercial represents actual yields consistently achieved on some of the better managed farms in good season.

Because of the diversity of the chemical composition of soils (Appendix A) both as they occur naturally and as a result of wide variations in cultural practices, general recommendations lead to a wastage of applied nutrients. For example, mixture "R" is being used throughout the Southern Province. It is very doubtful that this basal dressing meets the needs of all soil and crop situations. A refinement in recommendations followed by intensified sales promotion/educational effort is required.

FERTILIZER PRODUCT RECOMMENDATIONS

Recommendations for major field crops were published by the Research Branch of the Department of Agriculture in the Lima Crop memorandum (a LIMA=¼ ha) (Table 33). Dr. J.K. McPhillips, Senior Soil Chemist at the National Research Station; Mount Makulu, summed up the requirements for fertilizer in Zambia as follows:

> "Responses to all three nutrients have been established in Zambia. This is hardly surprising..a glance at the soils map indicates the generally low inherent fertility of the soils. Nowhere is found large areas of such naturally fertile soils that good yields can be attained without the use of fertilizers for even a short period of time. What is remarkable, however, is the high-yield potential such soils have for crop production provided fertilizers are used and the relatively modest requirements for P, K, and S. Nitrogen is an exception being required in fairly large amounts for all leguminous crops, but this is not unexpected when the organic matter is rarely above 3 will 1 being a medium value over large areas of sandveldt soils. What is surprising, indeed perhaps unique, is the need for sulfur in any program of crop fertilization in Zambia. Large responses to sulfur have been found throughout the country and sulfur deficiency has been established as being so widespread as to be endemic. The yield response of maize to sulfur along with N, P, and K can be as high as 6.3 tons/ha."

Similar yield responses have been obtained in other crops, e.g., cotton yields increased by 250 in Eastern Province, etc. As a direct consequence of the Research findings all fertilizer mixtures sold in Zambia are required to have a minimum of 10% sulfur. It is guaranteed that at the recommended levels, all crops will receive at least 20 Kg/ha of sulfur.

A recommendation of 1 Kg/ha of boron in solution is made for cotton.

TABLE 33 . FERTILIZER RECOMMENDATIONS FOR ZAMBIA*

CROP	AREA RATE PER LIMA**		AREA RATE PER LIMA		AREA RATE PER LIMA		AREA RATE PER LIMA		SUMMARY RATE (Kg OF NUTRIENT) PER HECTARE
	NORTHERN PROVINCE		SOUTHERN PROVINCE		WESTERN PROVINCE		EASTERN PROVINCE		
	GRADES - N - P - K - S		"		"		"		
1) Maize Basal	1 bag (50kgs)	20-10- 5-10	1 bag	20-20- 0-10	1 bag	20-10- 5-10	1 bag	20-10- 5-10	40-20-10-20
Top Dress	1 bag (AN/Urea)	33.5- 0- 0- 0	1 bag	33.5- 0- 0- 0	1 bag	33.5- 0- 0- 0	1 bag	33.5- 0- 0- 0	67
									107-20-10-20
2) Groundnuts Basal	1 bag (50kgs) Single Super	0-20- 0-12	1 bag	0-20- 0-12	1 bag	0-20- 0-12	1 bag	0-20- 0-12	0-40- 0-24
3) Rice Basal	1 bag (50kgs) Compound	10-20-10-10	1 bag	10-20-10-10	1 bag	10-20-10-10			20-40-20-20
Top Dress	1/2 bag A/N)	17- 0- 0- 0	1/2 bag	17- 0- 0- 0	1/2 bag	17- 0- 0- 0			33
									53-40-20-20
4) Soybean Basal	1 bag (50kgs)(D)	10-20-10-10							20-40-20-20
5) Finger Millet Basal	1 bag (50kgs)(X)	20-10- 5-10					1 bag	20-10- 5-10	40-20-10-20
6) Cassava	No Recommendation				No Recommendation				No Recommendation

TABLE 33 (cont.) FERTILIZER RECOMMENDATIONS FOR ZAMBIA*

CROP	AREA RATE PER LIMA		AREA RATE PER LIMA		AREA RATE PER LIMA		AREA RATE PER LIMA		SUMMARY RATE PER HECTARE FOR COUNTRY
	NORTHERN PROVINCE		SOUTHERN PROVINCE		WESTERN PROVINCE		EASTERN PROVINCE		
7) Beans (Bulk) Basal	1 bag (50kgs)	20-10-10-10	1 bag	10-20-10-10			1 bag	10-20-10-10	20-40-20-20
Top Dress	1 bag (AN)	33.5- 0- 0- 0	1 bag	33.5- 0- 0- 0			1 bag	33.5- 0- 0- 0	67 87-40-20-20
8) Sunflower Basal	1 bag (50kgs)	10-20-10-10			1 bag	10-20-10-10	1 bag	10-20-10-10	20-40-20-20
Top Dress	1 bag (AN)	33.5- 0- 0- 0			1 bag	33.5- 0- 0- 0	1 bag	33.5- 0- 0- 0	67 87-40-20-20
9) Cotton Basal			1 bag	20-20- 0-10			1 bag	20-20- 0-10	40-40- 0-20
10) Sorghum Basal			1 bag	20-20- 0-10	1 bag	20-10- 5-10	1 bag	20-20- 0-10	40-40- 0-20
11) Cowpeas Basal			1 bag	10-20-10-10	1 bag	10-20-10-10	1 bag	10-20-10-10	20-40-20-20
12) Soybeans Basal			1 bag	10-20-10-10			1 bag	10-20-10-10	20-40-20-20
13) Bulrush Millet Basal			1 bag	20-20- 0-10	1 bag	20-10- 5-10			40-20-10-20

* Taken from Lima Crop Memo, Department of Agriculture, Research Branch
LIMA represents 1/4 hectare

APPLICATION OF AGRICULTURAL LIMESTONE

The chemical composition of naturally occuring soils reveals a wide variation in the need for the application of agricultural lime. In Zambia nine soil groups are identified. They are: Red Clays, Sandveldt Soils, Barotse Soils, Black Clays, Kafue Alluvium, Floodplain Soils, Dambo Soils, Valley Soils and Rock and Rubble. These are further divided into 21 sub-groups (Table 34).

In Zambia the variation of climate is not sufficient to alter greatly the type of vegetation. The dominant type of material cover consists of dry deciduous woodland savanna with generally taller trees and denser canopy toward the north. Significant soil differences attributable to vegetation are confined to areas where the vegetation has been modified by a high water table, flooding, or seepage water. In these areas there is an accumulation of humidified organic residues.

The rainfall does affect the degree of development of Zambian soils. In the southern and southeastern areas where the rainfall is under 40/inches/year the soils have a base exchange saturation of 60-80%. They are only slightly acid, and in the uplands the cation exchange capacity (CEC) of the clay is 20-40 meg/100g. In the Luangwa, Zambezi, and other valleys the CEC ranges from 50 to 100 meg/100g of clay.

In the northern and northwestern parts of Zambia, where the rainfall approaches 50 in/yr, the soils are strongly leached, have a low base saturation, are strongly acid, and have a clay fraction consisting of kaolinite.

Over most of Zambia there is a close relationship between the soil and the parent material.

An analysis of 25 representatives profiles can form a basis for locating sites where limestone can be used to build up calcium and magnesium content of those soils that were inherently low in their nutrients (Table 10).

Because many soils have a low capacity to hold or store nutrients, they become exhausted after a few seasons of cultivation. Most are so low in organic matter that this is quickly oxidized and reserve of nutrients stored therein is likewise depleted. Further the application of fertilizers, while providing the required nutrients, tends to exhaust the soils inherent supply of calcium and magnesium and produce a residual acidity. Shown below are the relatively acidforming nature of various FERTILIZER MATERIALS.

MATERIAL	KG. OF $CaCO_3$ NEEDED TO NEUTRALIZE 100KG OF MATERIAL IN SOILS
UREA (46% N)	84
AN (33.5%)	59
AS (21% N)	110
SSP, TSP, MOP, SOP	0

The acid-forming nature of compounds would be in direct proportion the amount of nitrogen and sulfur contained in them. Repeated basal and topdressings to soils with low buffering capacity (E.F.C.) would lower the soil pH. When the soil pH declines to 4.5 or below, mineralogical changes occur within the soil which are not reversable. The soil is permanently damaged.

Table 34 The Main Soil Groups of Zambia

Soil Group Shown on Soil Map of Zambia	Subgroups
1. Red clays (including red brown loams)	a) Moderately leached b) Strongly leached
2. Sandveldt soils	a) Moderately leached b) Strongly leached c) Bleached d) Chipya

3.	Barotse sands	(a) Moderately leached red soils (b) Strongly leached red sands (c) Yellow soils (d) Podzolic soils (e) Podsols (f) Hydromorphic soils
4.	Black clays (including Kafue clays and Solonetzic grey clays and sandy clays)	
5.	Kafue basin alluvium	
6.	Floodplain and swamp soils (including seasonally waterlogged soils)	(a) Zambezi alluvial soils (b) Luangwa alluvial soils (c) Chambeshi alluvial soils (d) Swamp soils
7.	Dambo soils (not shown on the Soil Map of Zambia)	(a) Grey dambo soils (b) Dambo peats
8.	Valley soils (excluding Luangwa Valley soils)	(a) Brown valley soils (b) Brown podzolic soils (c) Solonetzic soils
9.	Rock and rubble	

Many areas have been cultivated with the application of recommended fertilizers for a sufficient number of years for the soil pH to be below safe levels. Frequently, farmers will apply more than the recommended dose in an effort to maintain former yield levels. This further accelerates the decline in soil pH and the yield response to applied fertilizer becomes less and less. No doubt areas exist where crop production is abandoned and the land returned to grazing of cattle. This, in part, accounts for the "over-fertilization" of some of the cultivated lands.

Table 35 Analysis of Representative Zambian Soil Profiles

	Depth inches	Coarse sand % 2.0-0.2	Fine sand % 0.2-0.02	Silt % 0.02-0.002	Clay % <0.002	Org C %	Total N %	Ca me%	Mg me%	K me%	Na me%	Cation Ex Cap	% Sat	pH	CEC me/100g Clay
		Particle Size (mm)													
Profile No. 3	0-5	2	27	25	46	1.94	0.138	42.2	7.5	0.8	0.2	52.7	96	[illegible]	—
	10-16	1	42	12	35	0.61	0.059	38.2	4.2	0.3	0.2	42.9	100	[illegible]	121
	16-24	1	63	8	28	0.33	0.043	34.3	5.8	0.2	0.2	40.5	100	[illegible]	146
Profile No. 4	0-3	4	27	17	52	2.05	0.128	36.2	22.5	0.6	0.4	61.5	97	[illegible]	—
	12-16	3	16	14	67	0.91	0.046	30.5	34.2	0.4	1.6	64.5	100	4.2	96
	42-48	2	14	16	68	0.31	0.016	22.3	38.7	0.5	2.8	62.3	100	8.5	92
Profile No. 5	0-10	—	30	24	45	1.05	0.082	27.8	14.0	0.7	0.2	41.0	100	6.5	—
	16-22	—	37	23	40	0.74	0.044	33.6	6.5	0.6	0.3	43.9	100	7.4	110
	30-35	1	42	25	32	0.34	0.038	38.2	7.6	0.6	1.2	33.8	100	7.7	106
Profile No. 6	0-8	33	57	5	5	1.20	0.050	2.2	1.2	0.3	0.1	4.4	85	6.3	—
	12-18	30	60	4	6	0.30	0.020	0.4	0.6	0.1	—	2.2	52	4.5	36
	44-56	36	31	22	11	0.20	0.020	1.3	1.3	0.2	0.1	3.6	76	5.0	33
Profile No. 7	0-6	29	45	6	20	2.75	0.140	10.4	4.0	0.9	—	17.2	88	6.1	—
	6-18	30	30	8	32	1.27	0.078	5.4	2.8	0.5	—	14.0	69	5.5	44
	24-30	24	29	7	40	0.78	0.054	5.5	3.4	0.4	—	13.4	69	5.8	34
Profile No. 8	0-6	19	64	6	11	1.12	0.070	3.6	1.3	0.4	—	5.7	93	5.3	—
	6-16	15	46	5	34	0.72	0.060	2.4	2.3	0.5	—	10.1	52	4.5	30
	16-12	10	42	6	42	0.58	0.054	3.0	3.5	0.5	—	11.7	59	4.8	28
	32-60	11	40	5	44	0.36	0.042	3.0	3.5	0.6	—	12.3	57	5.0	28
Profile No. 9	0-12	7	42	7	44	2.10	0.109	12.0	9.8	0.2	—	27.7	79	5.7	—
	12-30	6	27	13	54	1.01	0.083	10.8	6.4	0.2	—	23.7	73	6.4	44
	56-58	7	28	15	50	0.60	0.062	10.1	5.2	0.2	—	20.9	74	6.3	42
Profile No. 10	0-5	19	55	10	16	0.81	0.065	6.0	2.0	0.2	—	10.5	[illegible]	4.4?	—
	5-11	16	43	10	31	0.96	0.056	6.0	3.2	0.1	—	13.8	[illegible]	4.2	46
	11-17	14	35	12	39	0.87	0.055	10.0	2.4	0.1	—	14.4	[illegible]	4.4	37
	17-27	13	29	12	46	0.62	0.046	9.8	3.8	0.2	—	15.5	[illegible]	4.8	34
	27-40	11	29	10	50	0.41	0.039	10.4	3.6	0.2	—	15.3	[illegible]	5.1	31
	40-60	11	31	13	45	0.33	0.031	11.2	3.2	0.1	—	15.2	[illegible]	5.7	34
Profile No. 11	2-6	44	36	3	17	1.17	0.062	2.2	0.5	0.2	—	4.6	[illegible]	5.8	—
	12-18	44	20	3	33	0.44	0.034	1.3	0.5	0.2	—	3.8	[illegible]	5.6	12
	26-30	35	26	6	33	0.24	0.018	1.0	0.6	0.2	—	3.6	[illegible]	5.6	11
Profile No. 12	0-3	24	64	5	7	0.97	0.060	2.3	1.0	0.2	—	4.2	[illegible]	6.6	—
	3-17	25	63	2	10	0.38	0.033	0.4	0.1	0.2	—	3.0	[illegible]	5.8	30
	17-30	24	57	3	16	0.24	0.027	0.7	0.5	0.2	—	3.6	[illegible]	5.9	23
	30-48	19	48	3	30	0.24	0.023	0.8	0.9	0.1	—	4.6	[illegible]	5.6	15
	48-72	18	52	3	27	0.13	0.022	1.2	0.8	0.1	—	4.5	46	5.9	17
Profile No. 13	0-6	63	30	3	4	0.74	0.052	0.7	0.3	0.3	—	1.7	[illegible]	5.3	—
	13-18	47	35	3	15	0.23	0.026	0.8	0.2	0.3	—	2.5	[illegible]	5.4	17
	34-40	52	28	2	18	0.06	0.018	0.6	1.2	0.4	—	3.7	57	6.0	21
Profile No. 14	3-6	80	19	—	1	0.30	0.013	Ca+Mg	0.2	0.1	—	[illegible]	7	4.6	—
	28-30	68	30	—	2	0.18	0.005	Ca+Mg	0.1	0.1	—	0.7	19	4.7	35
Profile No. 15	1-6	19	79	—	2	0.93	0.054	2.4	0.5	0.1	—	3.5	47	5.3	—
	24-30	18	79	—	3	0.07	0.016	0.5	0.2	0.1	—	1.1	74	5.5	37
	54-60	18	76	1	5	0.07	0.010	0.4	0.2	0.1	—	0.9	88	4.8	16
Profile No. 16	0-6	37	42	2	19	1.25	0.072	0.5	0.2	0.2	—	5.3	16	4.1	—
	18-24	25	34	2	39	0.37	0.033	0.2	0.2	0.2	—	5.8	10	4.0	15
	48-52	24	35	4	37	0.10	0.022	0.3	0.0	0.3	—	4.9	12	4.0	13
Profile No. 17	0-6	24	63	4	9	0.72	0.030	2.3	1.2	0.2	—	5.0	72	4.9	—
	6-18	18	45	4	33	0.27	0.032	0.4	1.1	0.3	—	5.2	34	4.3	16
	36-40	11	50	4	35	0.10	0.022	0.3	0.8	0.3	—	5.4	25	4.1	15
Profile No. 18	0-7	18	43	15	24	—	—	0.4	0.3	0.2	—	1.3	7	4.2	—
	7-18	11	43	13	33	—	—	0.1	0.3	0.1	—	1.9	5	4.4	30
	14-48	11	31	10	48	—	—	0.1	0.2	0.0	—	2.2	5	4.4	13
	48-60	4	24	15	57	—	—	0.1	0.1	0.0	—	2.0	4	4.3	11
Profile No. 19	0-5	15	51	6	28	1.21	0.070	0.3	0.1	0.1	—	2.1	9	4.0	—
	18-24	10	46	6	38	0.51	0.042	0.1	0.2	0.1	—	2.6	5	4.0	17
	44-50	8	43	6	43	0.27	0.030	0.1	0.2	0.1	—	2.9	6	3.9	13
Profile No. 20	0-6	18	56	9	17	1.34	0.102	1.0	0.5	—	—	4.9	37	5.0	—
	12-18	6	65	7	22	0.23	0.012	0.3	0.3	—	—	2.7	27	4.5	12
	40-46	9	59	8	24	0.10	0.011	0.3	0.1	—	—	2.5	19	4.6	11
Profile No. 21	0-8	26	60	4	10	1.17	0.074	6.9	2.9	0.5	0.1	10.6	38	5.9	—
	10-20	36	54	4	6	0.35	0.026	5.3	1.0	0.2	0.2	5.4	100	7.0	107
	35-43	34	48	4	14	0.43	0.032	8.9	2.5	0.3	0.2	11.4	100	6.6	81
Profile No. 22	0-4	24	42	12	22	2.54	0.196	18.3	5.7	0.9	0.8	31.2	100	7.1	—
	8-12	9	25	22	44	0.57	0.048	29.1	10.3	0.5	6.0	24.8	[illegible]	8.0	16
	33-44	8	24	26	42	0.47	0.038	22.7	10.2	0.2	7.0	29.6	100	8.0	72
Profile No. 23	0-8	7	57	8	23	0.91	0.084	4.0	2.7	0.5	—	10.1	71	5.5	—
	17-24	5	49	8	39	0.78	0.074	3.2	2.1	0.2	—	11.1	49	5.2	29
	42-50	6	47	7	40	0.51	0.050	3.2	2.5	0.1	—	9.3	52	5.7	23
Profile No. 24	4-12	59	30	7	4	—	—	2.4	0.4	0.1	0.1	3.6	83	5.5	—
	20-27	30	36	1	31	—	—	5.4	11.2	0.1	0.7	19.9	47	6.7	64
	33-40	28	26	1	43	—	—	5.4	22.2	0.1	2.7	30.4	40	8.0	71
Profile No. 25	2-4	—	—	—	—	1.23	0.494	0.6	0.5	0.2	—	2.3	5	[illegible]	—
	4-17	—	—	—	—	1.93	0.819	1.2	0.5	0.2	—	3.1	9	5.3	—
	17-30	4	17	11	10	6.25	5.28	0.3	0.2	0.0	—	6.9	1	4.4	49

* Average pH
[illegible]
[illegible] micronutrients

Source: Brammer, H., Soils of Zambia, Rural Information Services, Ministry of Rural Development, 1976.

Liming soils to bring soil pH into proper range for optimum plant growth usually supplies sufficient calcium. Root growth of most crops depends on a supply of calcium and the proper pH in the root zone. Liming reduces the solubility and possible toxicity of aluminum, manganese, and copper. Liming also makes the phosphate component of compound fertilizers more available and soils tend to become more friable. Deficiencies of magnesium are most frequent on acid course-textured soils under the higher rainfall in the northern province. Grass tetany of livestock results from grazing forages low in magnesium. Applying dolomitic limestone provides an economic source for supplying this essential plant nutrient. Liming soils may also correct molybdenum deficiency.

Because a need exists to provide calcium, and magnesium, as well as, to raise the soil pH of Zambian soils, research advice from Mt. Makulu Experiment Station recommends from 500 to 2000 kg/ha of lime (see Fertilizer Recommendations). Typical crop responses to lime application are shown in Table 36. We have also established the following specifications for agricultural limestone: (1) a minimum neutralizing value (N.V.) of 80; (2) a magnesium content of at least 4%; and (3) a fineness of grind such that 100% passes through a 60-mesh screen and 20% through a 100-mesh screen.

Table 36 Response of Maize, Seed Cotton, and Groundnuts to Lime

Lime (kg/ha)	Monze	Magoye	Misamfu
Maize (yield 90-kg bags/ha, pH 4.5)			
0	26	5	8
1,000	47	28	19

	1968/69	1969/70
Seed cotton (yield kg/ha, pH 4.6)		
0	823	982
700	1,622	1,253 (residual)

	Magoye
Groundnuts (Makulu red, yield kg/ha, pH 4.7)	
0	1,123
2,000	2,023

Source: Fertilizer Recommendations in Zambia, Paper No. 6, J. K. McPhillips.

Sources of agricultural limestone in Zambia come from two types of calcareous rocks. The most common types are sedimentary, known as limestone and dolomite. These include the Lusaka dolomite, the stone which hosts the lead-zinc mineralization at Kabwe, the dolomites of the upper Roan formation which forms the hanging-wall sequence in the Copperbelt mines, the Kakontwe limestone at Solwezi, and the Matanda dolomite near the Luapula river.

The second type of calcareous rock is igneous known as carbonatite.

This type is rare except where volcanos erupted along most of the East African Rift Valley. In addition several plugs from former volcanos are found along older Rift valleys such as the Luangwa, Fiano and Zambezi Grafen, which control the course of the some rivers. In Zambia, carbonatite plugs form the Kalumwe, Nachomba, Mwambuto and Chawela intrusions in the Rufunsa District and Nkombwa Hill in Isoka District.

Summaries of chemical analyses of rocks from Isoka and Matanda deposites are respectively: Nkombwa Hill-$CaCO_3$ 45%, $MgCO_3$ 30-35%, neutralizing value 85-100; Matanda - $CaCO_3$ 50-55 $CaCO_3$, $MgCO_3$ about 40% and neutralizing value 96-100. The matanda resources above the water-table have been estimated at 5×10^6 tons, whereas they exceed 500×10^6 at Isoka.

Small scale mining (less than 20,000 tons/year) requires an investment of K500,000. Based upon an output of 5,000 tons/year the price of agricultural lime calculated at the quarries would be about 22K/ton. This compares with a price of 29.1K/t a (11/1/81) from Crushed Stones Ltd., Lusaka. A recent report from the Agricultural Finance Corporation indicates that a quarry for agricultural limestone will be opened at Chilala. This and the opening of many other deposites will bring the source of limestone closer to the cultivator and thus reduce the cost of transport to less than the 60K/ton now reported.

Because the application of agricultural limestone is, in fact, a renewing or improving the soils of Zambia by the application of minerals, it is a natural resource conservation measure. It is, therefore, in the national interest of Zambia to financially support a limestone application program through a payment in some form. As the subsidy is removed from fertilizer, it should be applied to this soil conservation effort, and provide for a balanced application of essential nutrients to ensure continued food production in Zambia.

In 1983, in spite of long established need based upon research, no national program for making lime available to farmers exists. In 1981 only 5, 234 tons of lime were sold compared to the application of 13,760 tons of sulfur Table . Since 1975 over 70,000 tons of sulfur and 68, 700 tons of nitrogen have been sold for application to the soils of Zambia. The acidity thus produced is restricting crop yields. Certainly the availability of lime at the farmer level is a most pressing fertilizer problem.

TABLE 37 - PRODUCTION AND SALES OF AGRICULTURAL LIME BY CRUSHED STONE SALES LTD.

Calendar Year/Month	Production	Sales	Closing Stock
	----------MT----------		
1976	2,826	2,529	297
1977	3,894	2,952	1,239
1978	1,864	1,493	1,610
1979	4,014	3,924	1,700
1980	4,580	5,003	1,277
1981	3,993	5,294	147
1981 January	113	1,390*	NIL
February	86	60	26
March	95	94	1
April	100	100	NIL
May	131	328	3
June	247	114	135
July	191	324	2
August	573	566	9
September	460	454	15
October	597	465	147
November	836	856	127
December	564	543	147

*Adjusted to arrive at a fair Closing Stock because in the past there was some discrepencies in Closing Stock.

SOURCE:- Annual Agricultural Statistical Bulletin 1981

Central Statistical Office 11/82

XI. FERTILIZER EDUCATION

The use of chemical fertilizer in Zambia is relatively new. Most Zambian farmers know that fertilizer will increase crop production. Increasing amounts are used each crop season! Research has developed general recommendations for each crop and devised a demonstration technique to show the farmer the proper application methods and rates (See - LIMA Crop Memos). To ensure efficient nutrient use, these general recommendations should be refined to comply with local soil and crop conditions. Research can improve the fertilizer message by aggressively acquiring crop response curves on the many soil conditions for the three levels of farm management now recognized in Zambia. Such information placed in the hands of soil fertility specialists at provincial soil analysis and interpretation were undertaken, further refinement in the extension fertilizer message would substantially increase fertilizer use efficiency by farmers. To reach this level of competency all who come in contact with farmers i.e. extension workers, retail outlet managers, regional and provincial fertilizer marketers, must know the techniques, methods and importance of such a system to the individual farmer and the nation as a whole.

The current level of training of the extension workers, and those operating within the marketing system leaves much to be desired. In Central Province and extension specialist advised that he was undertaking a comprehensive fertilizer training program because the extension workers did not know the LIMA program, the nature and functions of fertilizer nutrients proper methods of application or other techniques related to fertilizer use. In Southern Province, the Provincial Agriculture Officer stated that his field staff knew the LIMA program but he had difficulty in motivating his field men to call on farmers. The excuse he most often encountered was the lack of transport.

An examination of the size of the extension staff reveals only 1 worker for each 500-600 farm units. This indicates a need for additional technology transfer support at the rural depot (retail) level by well schooled individuals, and for at least a doubling of the size of the extension staff. The fertilizer marketing organizations must assume an expanded role in any educational effort with farmers. They should sponsor demonstrations, field days, farmer meetings, as well as solicite business on the farm. They could take samples of soil from farmers fields, have it analyzed and interpretations made by an extension soils expert, and return the recommendations to the farm for sales promotion purposes. Obviously, such an effort requires a major teaching or "train-the-trainer" program involving both formal and on-the-job supervision over a period of several years. In addition, those concerned with teaching farmers must be mobilized. For example, the assigned transport for extension workers (Table 38) shows that only 149 vehicles are provided for 316 workers. Many of the "campus" have no workers, and a number of the vehicles require spares. Obviously, the magnitude of the task, the lack of mobility, the acquisition of adequate technical skills, and, probably, the compensation of the farm advisors thwart the adequate transfer of fertilizer use technology to all classes of Zambian farmers.

A new program called, "The National Lima Fertilizer Program" has been recently instituted. This program, supported by FAO and other donors is designed to improve extension's delivery of information about fertilizer to the small farmer by providing Extension with adequate resources and training of manpower. Current enrollments of farmers for participation this coming crop season are encouraging. In addition, the program is designed to provide a growing data base of fertilizer use by the small farmer. This type of program needs to be encouraged.

But this educational effort is far from enough. As is pointed out elsewhere, approximately 30 of the imported fertilizer is lost before it reaches the farm. In view of the millions of Kwacha so wasted, additional facilities and improved marketing management skills are urgently needed. Rural depots require secure, inexpensive storage facilities. Procedures for sales forecasting, inventory management, packaging, in-house warehousing, shipping, and handling can all be improved through formal and continued on-the-job training. Research on new and improved products could allow reduced physical distribution costs and lower the cost of individual nutrients to the farmer. Savings in physical distribution costs could be used to support intensive educational programs.

TABLE 38 - TRANSPORT ASSIGNED TO EXTENSION STAFF IN SOUTHERN PROVINCE OF ZAMBIA, DECEMBER, 1982

District	Number of Workers	Bicycles	Vehicles Assigned	
			Motor Bicycles	Land Rovers
Namwala	35	16	1	2
Kalomo	44	21	0	1
Livingstone	28	18	1	1
Mazabuka	47	20	0	1
Monze	55	20	1	1
Gwembe	51	21	1	1
Choma	56	20	0	2
TOTAL	316	136	4	9

Note: Ten extension camps without staff
Bicycle spares in some district prevent use

Source: Director of Planning, MAWD, 1983

The development of managerial skills throughout a more unified fertilizer market development system is very important. The communications and methods required to organize, plan, coordinate, execute and control a fertilizer system can be taught through formal and on-the-job coaching or advising methods. Techniques for the maintenance management of Zambian fertilizer manufacturing facilities form an integral part of any fertilizer training program.

An organization is only as good as the skills of those people who operate within it. Ultimately on-the-job, day to day supervision must be exercised so that each employee attains his highest level of productivity. The existing programs for personnel development constitute a severe constraint on the entire fertilizer system. The fast rate of expansion of the cooperative system makes the need of skill development, as opposed to career course work, even more urgent. Without doubt personnel selection and career development must be attacked if significant wastage of fertilizers and foreign exchange is to be prevented. An efficient system should be devised and developed as a Zambian National Fertilizer Program as soon as possible.

XII. PERSONNEL DEVELOPMENT

The function of any training program is to develop each member of the organization to his or her greatest level of performance. The difficult task in building any fertilizer organization is not physical, such as bricks, mortar and rail cars. It is selecting and training the right people. Most all successful fertilizer organizations contain both manufacturing and marketing arms under one general management. The transfer of manufacturing technology is highly specialized and is usually accomplished by the engineering construction firm prior to and during part of operations.

Development of marketing personnel not only involves many specialities but also a very large number of individuals.- marketing management agronomists, sales management, distribution managers, retailers, and farmer-customers. To be successfully implemented such development must begin at the apex of the organization.

Management Development

Formal education to the M.B.A. level is recommended regardless of the technical background of the individual. Frequently, this will involve remedial courses in accounting, general business administration, marketing, finance, personnel management, and finance before advanced educational work can begin. A specialization within the M.B.A. degree should be in marketing with emphasis on those matters pertaining to a development plan for use in his home country. To staff the apex organization specialized individuals should be selected with proven records and experience in their speciality, i.e.

Agronomists with advanced degrees and proven records whether from industry or the academic fields; distribution personnel experienced in product handling, but not necessarily in agricultural products; advertising and sales promotion personnel experienced but not necessarily in agriculture; market researchers with proven records again not necessarily in fertilizers.

Recognizing that many of NAMBOARD and Cooperative management staff have had both job experience and training, in depth development of their organization requires in-country Basic marketing training.

This 30-day program covers seven subject matter areas as: organization policies, general agriculture, agronomy, market records, market procedures, communications, accounting procedures, marketing management.

For the field sales staff a one-week course or professional selling follows. For those in supervising other employees a 5-day course in the Practice of Supervision is offered during the first year of employment. For Provincial Managers, both present and potential, a 10-day course in marketing management is recommended.

None of the above addresses the longer range requirements for sound institutional buildings. This necessitates formal pursuit of specialized staff development at institutes of higher learning. For example, the obtaining of advanced degrees in such subject matters as agricultural economics, accounting, soil chemestry, crop sciences, business administration, marketing, personnel management, etc. Selection of individuals for this type of training requires a long-range staff development plan which reflects future organizational development needs.

ANNEX - A

SOCIO-ECONOMIC AND AGRICULTURAL SETTING

AGRICULTURAL SECTOR OVERVIEW

The Republic of Zambia occupies tropical high plateau country in south-central Africa. It is bordered to the north by Tanzania and Zaire; to the east by Malawi and Mozambique; to the south by Zimbabwe, Botswana and Namibia; and to the west by Angola. The area is 752,614 km^2, which is slightly larger than Texas.

Zambia's population (1980 census) was 5.7 million with an annual growth rate of more than 3.1%. Seventy percent live in rural areas where remote tracts are virtually unpopulated while limited areas exceed their carrying capacity under traditional cultivation. One-third live in urban centers on the line of rail. The capital is Lusaka with a 1980 population of 538,469. The other major cities are Kitwe with a population of 514,794 and Ndola with 282,439 inhabitants. Other cities are Chingola (190,000), Mufulira (136,000), Luanshya (121,000), Kabwe (98,000), and Livingstone (58,000). Of Zambia's total population (1981) of 5.961 million, an estimated 3,931 million were classed as agricultural. Of the economically active population of 2.418 million, 65.9% are engaged in agriculture (Table 1). Of the agricultural population, 36% were economically active in 1981. Over 98% of the people are African divided into more than 70 Bantu-speaking tribes. The adult literacy rate in 1977 was 44%. The life expectancy at birth was 49 years in 1980. In the same year 47% were urban and urban growth rate was 6.7%/year.

The type of government is a republic whose 1973 constitution provided for a strong president as chief of state. National policy is formulated by a 25-member Central Committee of the United National Independence Party (UNIP), the sole legal party in Zambia. The cabinet executes the central committee's policy. The second-ranking person is the UNIP's secretary general, rather than the prime minister. The cabinet is appointed by the president from membership of the National Assembly. Zambia is divided into nine provinces, each administered by a central committee member (Figure 1).

The economy of Zambia has steadily worsened. The gross domestic product (GDP) has declined from 1,583 in 1975 to 1,461 million Kwacha (K) in 1981

Table 1. Total Economically Active and Agricultural Population of Zambia

Year	Population		Economically Active Population		
	Total	Agricultural	Total	In Agriculture	Percent in Agriculture
	('000)				
1970	4,242	3,089	1,648	1,200	72.8
1975	4,912	3,429	1,847	1,290	69.8
1979	5,580	3,755	2,039	1,372	67.3
1980	5,766	3,842	2,092	1,394	66.6
1981	5,961	3,931	2,148	1,416	65.9

Source: FAO Production Yearbook, Volume 35, 1981.

at 1975 prices. At current prices an increase during this period to K 2,990 million occurred. The 1975-based wholesale price index stood at 242.4 in 1981, home and import goods index at 266.0. Zambia's economy in 1982 was faced with severe external and internal difficulties. Foreign reserves have dwindled while external payment arrears have increased. In order to maintain government services, it has been necessary to resort to fiscal deficits which have resulted in an increased rate of domestic inflation. The scarcity of foreign exchange and the constraints on domestic resources have reduced the level of imports, investment, and utilization of industrial capacity. Production has declined in real terms. The 1982 situation was further compounded by adverse weather conditions in the last two seasons and Zambia was forced to import maize to supplement the reduced national production. The GDP increased by about 6% at current prices to K 3,221 million as against an increase of only 2.1% in 1981.

These data compare with a GDP of 7% annual growth rate for the period 1960-70 and 0.7% for the period 1970-80. In 1980 the GDP of US $3,790 million was distributed as 15% agriculture, 39% industry, 17% manufacturing, and 46% services. In 1960 the GDP of US $680 million was distributed as 63% industry, 11% agriculture, 4% manufacturing, and 26% services. Zambia is considered a middle-income oil importing country highly dependent upon the value of copper exports for foreign exchange earnings. The overall balance of payments reflects the changes in world copper prices. The balance of payments (millions of SDRS) in 1975 was -59; in 1976, -61; in 1977, -25; in 1978, -163; in 1979, -53; and in 1980, 13. The performance of Zambia Consolidated Copper Mines (ZCCM) mirrors the economic problem. By producing copper at a cost well above that at which it can be sold, ZCCM has plunged into the red and increased its expenditures and borrowings to the limit. Zambia's current account balance in 1980 was US -$508 million and its interest payments on external public debt was US $98 million.

The Zambian 1983 budget for recurrent expenditure (Table 2) of K 1,246.1 million is only marginally above the actual expenditure of K 1,234 in 1982. A number of decisions have been taken to restrain spending: (1) travel restrictions, (2) reduction of subsidies, and (3) stricter control of expenditures by individual ministries. In 1983 the subsidies have been reduced from K 153.4 million to K 52.8 million, mainly in the agricultural sector and in particular to keep the cost of fertilizer down.

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Table 2. The Zambia 1983 Budget (million Kwacha)

Recurrent Expenditure	[illegible]
Constitutional and Statutory Expenditure	[illegible]
Total Recurrent Expenditure	[illegible]
Capital Expenditure	[illegible]
Total Expenditure	[illegible]
Recurrent Revenue	[illegible]
Overall Deficit	[illegible]
Financed by:	
Internal Loans	[illegible]
External Loans	[illegible]
Bank Borrowing	[illegible]

Expenditure allocations to individual Ministries are as follows:

Recurrent Expenditure

Ministry	*K million*	*% increase*
Health	103.9	9
Agriculture & Water Development	86.6	40
Higher Education	68.9	84
Works & Supply	60.8	44
Police	47.3	12

Capital Expenditure

Ministry	*K million*
Agriculture & Water Development, Industries and Marketing	83.7
Works and Supply	53.9
Power, Transport & Communications	32.6
Education and Health	23.7

Indirect Tax Increases

The Prime Minister's Inter-Departmental Committee on Tax Collection [illegible] income tax from [illegible] companies. [illegible] announced an income tax rate rise to individuals and companies.

— [illegible]

— [illegible]

Petroleum [illegible]

Customs duty [illegible]

— All minerals exported would be subject to an export tax which has been increased [illegible] of the export value and the Government hoped to raise K[illegible] million [illegible] from Anglo American Corporation [illegible] the rate which was the lowest taxation of the industry.

Sales tax [illegible]

Tolls [illegible]

[illegible]

Stamp Duty [illegible]

Source: African Research Bulletin, 1983.

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AGRICULTURAL RESOURCES

Zambia has the area, climate and soil for major agricultural development both for home consumption and for export. Only about one sixth of the estimated 60 million hectares of arable land is currently being farmed. The main crops grown are maize, groundnuts, sunflower, millet, sorghum, beans, tobacco and cotton; livestock and poultry are also important. Along the line of rail from Livingstone to the Copperbelt there are substantial and efficient commercial farm. Away from the main transport corridor the land is sparsely settled and agriculture is mostly for subsistence.

The agricultural sector has suffered in the past from Government insistence on low prices to keep down the prices of food for the heavily urbanised population, and from occasional difficulties in the availability and distribution of credit and of inputs such as fertilizer, compounded in recent years by the shortage of foreign exchange. Since 1980, however, the Government of Zambia has been pursuing a strategy designed to increase agricultural production and reach self-sufficiency in food. This strategy included bringing producer prices up to economic levels, promoting agro-industries, increasing allocations for rural infrastructure, divesting the National Agricultural Marketing Board of many of its functions in favour of the Provincial Agricultural Co-operative Unions, and developing two large Government-owned Farms in each province with the help of outside aid donors. As a further incentive the Government announced the producer prices for the 1982/83 and 1983/84 seasons in July, 1982 thereby giving farmers ample time to decide what crops and hectarage to plant. Furthermore, farming machinery, equipment and implements will be depreciated at 50 per cent of the cost of the asset over two years. The farming income tax rate for both individuals and companies has been reduced to 15 per cent. The selective employment tax has been removed on incomes of expatriate personnel in the agricultural sector. The Government has also granted a development allowance of 10 per cent of total expenditure in any change year for the

development of cash crops such as tea, coffee, bananas and citrus fruits.

Although the Sector remains vulnerable to weather conditions as was the case in 1981 when drought forced the import of maize, it has great potential. In order to lessen the dependance upon the weather, the Zambian Government is pursuing a deliberate policy of developing irrigation on both a small scaleand large scale basis.

Geography

Zambia occupies a tropical high plateau between 8°S and 18° south latitude in central Africa. Most of the land lies at an altitude of 915 and 1,500m. A central spine, with an overall elevation of 1,350m, bisects the country from north to south. To the northeast another, slightly more lofty, ridge angles at 45° toward the border of Tanzania. This upland area includes the Muchinga Mountains, 320 km long, which reach an altitude of 1,830m north of Nyika. The highest point in Zambia is on the Nyika plateau, which reaches 2,171m on the Malawi border. Between the Muchinga Mountains and Lake Mweru on the Zaire border in the north, the plateau is flat and elevated, except for the swampy regions around Lake Bangweulu. West of the central north-south ridge the plateau is also largely flat but the general elevation drops to 1,100m. The valleys of the lower Zambezi and Luangwa Rivers are only 450-900m high. The lowest-lying area of the country is at the confluence of these rivers.

Mantled with thickly accumulated debris and mostly covered with secondary woodland of stunted, mixed deciduous and evergreen trees, the surface represents ages of gradation interspersed with periods of uplift accompanied by warping. Wide shallow basins with lakes, swamps and grassy plains, and isolated hills and ridges break the monotony. In the west unconsolidated Kalahari sands were deposited by wind in great depth. Certain areas also developed rift block valleys.

Three-quarters of Zambia drains to the Zambezi. From the Barotse floodplain the river flows south then east along the Zimbabwe border, plunging over the Victoria Falls to enter a gorge section now largely occupied by the 274-km manmade Lake Kariba. The Kafue River drains the copper belt, flowing south through swamp, game park, floodplain, and finally into a gorge section to the Zambezi. The Kafue supplies much water for mines and towns of the railway zone. The other main tributary, the Luangwa, flows through its drier, undeveloped rifted valley and another game park. Northern Zambia mostly drains to the Congo, from the Chambeshi River in the northeast, through the Bangweulu Lake, sand and swamp complex, and north via the Luapula River. Zambian rivers show marked seasonal discharge variation with February-May peaks after the rains take effect and October-November low water before they begin. Disrupted by rapids and falls, they are little used for commercial navigation.

Important plateau features are dambos--shallow, linear, moisture-retaining concavities that provide dry season water and thus rural settlement patterns.

Climate

The climate of Zambia is modified by the altitude and does not present extremes. Except in the low-lying valleys Zambia's climate is temperate and mild. The mean summer temperature is 22°C and the mean winter temperature is 20°C. There are three distinct seasons: cool and dry from May to August, hot and dry from September to October, and rainy from November to April.

In the Zambezi Valley less than 250mm of rainfall a year is not uncommon but most of the plateau receives about 750-1,000mm of rain. The areas near Lake Tanganyika in the northeast and near Mwinilunga in the far northwest usually have the longest and wettest rainy seasons. The rainfall peaks in December. At Kasama in the northern province the rains exceed 200mm during each of the months from November through April for a total of about 1,600mm for the growing season. In the central province at the Kabwe Research Station the rainfall in a wet season is about, 1,100mm with March and April being drier than in the northern and Luapula provinces. The main influences on the weather are the Intertropical Convergence Zone and the Antartic airflow across the south of the African Continent.

Soils

For discussion of soils see section on application of lime and Appendix B.

Land Use

Of the total land area of 75,261,800 ha, 5,108 ha (6.8%) is cultivated, 35,000,000 ha (46.5%) is in permanent pasture, and 20,450,000 ha is in forest and woodland. An additional 5 million ha can be made arable and 40 million ha is potentially arable. An estimated 6,000 ha is irrigated. Based on FAO index where 1969-71 = 100, Zambia food production was 135 in 1981 and the agricultural production was 134. On a per capita basis the food production index stood at 96 and the agricultural production at 95 in 1986 (Table 4)

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Zambian agriculture is characterized by a sharp contrast between commercial farming for cash as developed by European settlers and subsistence farming carried on by the vast majority of Africans. The large-scale commercial farms are concentrated along the railroad between Livingstone and Kabwe. Subsistence or shifting cultivation is the rule elsewhere.

The prevailing land-use practices on African farms are both primitive and wasteful. The most common methods of farming are (1) mound cultivation; (2) chitemene or slash and burn; (3) grassland cultivation, floodplain, or dambo; and (4) cattle grazing. These methods are sometimes used in combination. Semi-permanent hoe and ox-plow cultivation is practiced in about one-fourth of the country, including all of the western and part of the northwestern provinces and on the Zambezi Escarpment. Cattle grazing is widespread in these areas and seasonal migrations occur in the dry period from about June to December. Semi-permanent cultivation is also practiced in the generally fertile Luangwa River Valley. The presence of the tsetse fly in the entire valley prevents cattle raising.

Table 3. Food and Agricultural Production Indexes for Zambia and Other Countries, 1981 (1969-71 = 100)

Area	Food Index	Agricultural Index
Zambia	96	95
Africa	92	90
Malawi	105	109
Mozambique	70	67
Namibia	77	78
Zimbabwe	111	106
Indonesia	123	120
Malaysia	142	125
Pakistan	106	104
Philippines	121	122
Thailand	141	136
Portugal	61	61

SOURCE: FAO Production Yearbook, 1981.

Land Tenure

Zambian agriculture is characterized by a sharp contrast between commercial farming for cash and subsistence farming carried on by the vast majority of Africans. The transition from tribal to modern cultivation has been hindered by the traditional forms of tenure. Under customary law, ownership of land is theoretically vested in the tribe with the paramaount chief as the custodian. But land rights could be conveyed to individuals and there is some security of tenure. Sale of land is not permitted but land can be transferred by a farmer to members of his family usually through matrilineal inheritence. At independence the GRZ took over all land in an effort to detribalize tenure. It also encouraged sale and acquisition of land and its disposition by individual testament. Although lands under cultivation by Europeans have not been taken over, those abandoned by European farmers leaving Zambia have been redistributed to Africans.

In many villages the area under cultivation by each farming family will be a mixture of old and new plots or gardens. Under chitemene cultivation, it is customary to burn off a new area of garden each year or two, while another plot that has been lying follow may be reopened. Thus at any one tome a given family may be cultivating both new plots, plots inherited from the mother or mother's kinship group, and other plots derived from the father or paterna' kinship group, in proportions that may vary from year to year.

Fragmentation of holdings is common but for the most part is a result not of inheritance but of a system of cultivation. Also the individual has free access to vacant land and maintains his rights over fallow. Often a tribal family farms a number of widely separted plots, a situation resulting in inefficient cultivation. Consolidation of holdings in an important step in the transition from subsistence farming to more productive cultivation.

Under tribal systems cultivation tended to deplete the land. With the introduction of the ox plow it became necessary to clear the land of stumps. Such land attained a higher value. Under tribal tenure systems the adoption of better farming methods and the improvement of the land was discouraged. A couple producing above the subsistence needs of their immediate family may find that they must support less fortunate members of their kinship group. Thus the extra production did not raise their standard of living and they have acquired dependents.

There are three kinds of rural households or farmers in Zambia: commercial farmers, emergent farmers, and traditional farmers. The commercial farmers have been predominately white farmers who numbered 1,000 at independenc The number of commercial farmers is currently down to 400. Of this remaining group, perhaps a fourth are African Zambian. This group is in the top 5% or so of all income earners in the country.

The emergent farmers have been defined as thos who farm less than 20 ha and sell over 50% of what they produce. They can be viewed as comparatively successful cash crop farmers. They tend to use improved farm technology (plows and oxen, fertilizer, insecticides, hybrid seeds) and they have received more government support than the traditional farmers. The emergent farmers have been gradually developing the high potential land on the east, southern, and central plateaus. Much of this land has been made available by the departure of the expatriate commercial farmers who began leaving Zambia after independence. Estimates of the size of the group of emergent farmers vary from 60,000 to 120,000.

TRANSPORT

Zambia is heavily dependant upon foreign trade. Thus the transport sector is vital. In 1975 Zambia opened road, rail and pipeline links with Dar-es-Salaam in Tanzania. The 1860 kilometer Railway (TAZARA) handled most of the exports and imports between 1975 and 1979. In 1980 the Southern route from East London was reopened. If the restoration of the Benguela Railway through Zaire to Angola becomes possible, that too will help Zambia. It is used to carry substantial portions of the copper exports.

Zambia has 2,000 km of Railways, 5,000+ km of hand surfaced roads, 8,000 km of gravel roads and 22,000 km of other roadways. A 1,700 km pipeline pumps crude oil from Dar-es-Salaam to the oil refineries at Ndola.

In 1981, 55.3% of the total foreign trade was moved over the Dar-es-Salaam route while 40.5% was through Zimbabwe. Almost 430,000 metric tons (66.3%) were exported and over 340,000 metric tons (45.7%) were imported through Dar-es-Salaam in 1981. Over 190,000 metric tons (29.3%) of exports and over 374,000 metric tons (50.2%) moved by the Southern Route through Zimbabwe in 1981.

Road transport accounted for 1,070,909 metric tons or 76.95 of the total foreign trade. The decline of the role of Road transport during the period 1979 to 1981 is attributed to shortages of spare parts experienced by the Zambia Tanzania Road Services which prevented rehabilitation of their large ageing fleet of vehicles. The extra transport burdens placed on the Rail system created operational problems for TAZARA.

In addition, congestion at the port of Dar-es-Salaam and the resulting delay with which goods cleared this port no doubt caused further difficulties. Shortages of wagons also adversely affected operations. During the 1982/83 financial year, a total of 1,000 old wagons were planned to be scrapped and replaced with new ones. With sufficient wagons, the railways will transport about 60,000 tons of coal per month to its major consumers: the mining industry (60-70%), the Chilanga Cement, Nitrogen Chemicals and Zambia Sugar Companies.

Fertilizer is transported by rail to intermediate storage whenever possible. Along the line-of-rail in Southern Province for example, fertilizer is off-loaded from rail into district depots. It is then transported to district and rural depots in trucks with 40-ton and 10-ton capacity. In spite of the large amounts hauled in season, trucks are available. Some rural depots cannot be reached during the rainy season because of the poor quality of the road system. The cost of transport is ..... Kw/T/Km for the first 80Km, ... Kw/T/Km for the second 80 Km (up to 160 Km) and ..... Kw/T/Km for distances over 160 Km.

Crop Production

Maize, Millet, sorghum, sugarcane, cassava, roots and tubers, and vegetables are the principal crops grown in Zambia (Table 4). Maize is the dominant staple and major subsistence and cash crop. It is grown to some extent throughout the country, though most of the marketed maize comes from the central and southern provinces. Maize is also used as feed for livestock and poultry. Cassava is a major crop among fishing populations around the lakes, along the border with Zaire, and in the Far West. Peanuts are grown throughout the country primarily as a subsistence crop.

Zambia is currently self-sufficient in sugar production. In the late 1970s domestic wheat production was only a fraction of food requirement. In recent years the GRZ has increased the support price and wheat production is expected to meet domestic need by 1990. Currently, Zambia produces 41% of its wheat requirements and imports the rest at a cost of US $30 in 1982. According to the Rural Development Corporation, a quasi-government institution, the 1983 domestic wheat demand will soar to 200,000 tons against the 1982 need of 180,000 tons. Zambia is Africa's third largest wheat importer after Egypt and Ethiopia. Most of the wheat trade is with Australia from which, last year, Zambia imported 77,000 tons.

To arrest this drain on foreign exchange a crash program aimed at ensuring domestic production of 50% of the 1983 total demand. The program includes an irrigation in Mpongwe province and a US $4 million Zambia-Canada wheat growing project in Mbala. On 16 suitable other rainfed sites, yields in excess of 2 tons/ha were obtained.

Zambia Agricultural Development Limited, a subsidiary of the Rural Development Corporation, has started two wheat-growing programs-- the 500-ha Minisini farm and the Chisamba project which has 5,000 ha of irrigated wheat. Together these projects will cost US $15 million.

The GRZ has increased the wheat price from US $28 to US $35/kg--an increase of 23% in a single season. International market price is US $15/kg. Other incentives are duty exemptions on farm equipment, preferential taxation, and foreign exchange allowances. The main stumbling block, according to Dr. Teddy Hurd, the leader of the wheat program, is the response from farmers.

Cotton in Zambia is produced mainly by both large and small farmers. In 1978 the state-owned Lint Compnay of Zambia (Linteo) took overall cotton marketing functions, gimneries in Lusaka, and cotton-producing areas. Linteo has offices in all the main cotton-growing areas in the central, eastern, and southern provinces. In addition it has set up 300 cotton-buying stations in rural areas. In the central and southern provinces, Linteo is being assisted by a cotton development project financed by the European Economic Community through a US $7 million loan and a US $2 million grant. In 1980/81, 31,000 ha was planted by 20,000 farmers. Linteo has spent a total of US $20 million to revamp Zambia's cotton industry. In 1982 estimated yields were 20-24 million kg of seed cotton providing 7 million kg of lint. This is well above the requirements of Zambia's two mills. The 1981 surplus of 3.5 million kg of lint was sold to a British brokerage firm earning Zambia US $3.4 million. Linteo expects seed cotton production to reach 35 million kg in 1985, giving 12,000t of lint, of which 7,000 tons will be used locally. Tea and coffee have also received government support in an effort to increase production.

Major cash crops are cotton and tobacco.

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By far the principle crop moving into official marketing channels is maize. Collected from farmers by the Cooperative Unions the crop is stored on cement hard stands and silos and transferred to NAMBoard at strategic storage sites. The improved variety is handled in 90 Kg bags by hand. All amounts moved through these official channels range from over 331,000 tons in 1979 to over 693,000 tons in 1981 (Table 4A).

Producer prices for all crops have increased substantially since 1976 (Table 4B). Maize increased 254% soyabeans 248%, wheat 200%, sunflower 208%, and groundnuts 192% during the period 1976 to 1982. The producer price for seed cotton remaining relatively constant.

TABLE 4a MARKETED AGRICULTURAL PRODUCTION IN ZAMBIA 1976 - 1982 (a)

	UNIT	1976	1977	1978	1979	1980	1981	1982(b)
Maize	Tonnes	746,426	693,000	657,000	331,255	382,988	693,341	508,328
Tobacco: Virginia		6,262	5,588	3,700	4,590	4,127	2,319	1,861
Burley		212	212	264	381	554	665	704
Sugar		84,028	71,203	73,450	102,148	110,601	102,318	117,059
Groundnuts		8,371	7,229	2,234	2,737	2,028	1,320	810
Sunflower		13,079	13,320	11,355	12,869	20,279	19,223	20,362
Seed Cotton		3,891	8,929	10,200	14,916	15,000	17,177	13,171
Wheat		3,459	4,741	6,400	4,322	6,670	11,478	12,510
Paddy Rice		2,224	2,090	2,970	1,686	2,511	2,673	2,826
Soya Beans		944	1,274	2,844	1,294	1,989	3,673	5,140
Coffee		33.1	24	55	-	28	40	-
Tea (Green Leaf)		-	64	85	-	314	363	395
Cattle	Head	77,000	79,700	80,000	84,000	92,358	100,052	105,000
Milk	100 Litre	10,530	10,353	9,539	9,326	10,207	11,705	15,000
Pigs	Head	50,246	35,816	42,388	48,416	47,894	44,000	40,000
Eggs	Million	178	173	90.0	155	137	113	144
Meat Birds	Million	11.6	13	12.5	12.2	13.8	9.8	13.0
Day old chicks (exports)	Million	1.4	1.43	1.3	0.4	0.7	0.2	0.3

SOURCE: Central Statistical Office and Ministry of Agriculture and Water Development.

Notes: (a) Year indicates end of harvesting season e.g. 1981/82 = 1982
(b) Preliminary

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TABLE - AGRICULTURAL PRODUCER PRICES IN ZAMBIA, 1979-1982

	UNIT	1976	1977	1978	1979	1980	1981	1982
		K W A C H A						
Maize (a)	90 kg Bag	6.30	6.80	9.00	9.00	11.70	13.50	16.00
Groundnuts(b)	80 kg Bag	25.00	28.60	32.00	32.00	35.00	46.05	48.00
Sunflower	50 kg Bag	10.00	12.50	13.70	13.70	16.40	17.60	20.75
Soya Beans	90 kg Bag	17.00	21.50	25.50	33.00	33.00	36.30	42.21
Wheat	90 kg Bag	16.00	18.00	20.00	20.00	24.00	26.00	32.00
Milk	Litre	0.18	0.20	0.21	0.25	0.25	0.36	0.43
Paddy Rice	90 kg Bag	16.20	16.20	18.00	18.00	18.00	18.60	28.00
Tobacco, Virgina (c)	kg	1.04	1.45	1.45	1.51	1.57	1.65	2.40
Seed Cotton (d)	kg	0.40	0.46	0.46	0.46	0.46	0.46	0.47

SOURCE: Central Statistical Office and Ministry of Agriculture and Water Development.

NOTE: Year indicates end of Harvesting Seasons, e.g. 1981/82 = 1982

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Planting and harvest seasons for principal crops are as follows:

Crop	Planting Season	Harvest Season
Coffee	March	September-October
Cereals and grains		
Barley	May	September-October
Corn	November-December	April-June
Millet	November-December	April-June
Oats	November-December	April-June
Rice	October-November	April
Wheat (Kafue Flats)	April-May	October-November
Fibers		
Cotton	October-November	April-May
Fruits	February or July	March-May
Oilseeds		
Peanuts	November-December	March
Sugarcane	December-January	May-June
Tobacco		
Various varieties (Mainly flue cured)	October-December	January-April
Turkish	February	March-July
Vegetables		
Benas	January-February	April
Cassava (manioc)[a]	September-December	December-March
Peas	January	April
Potatoes	November-January	June-July

a. Harvested from 12 to 18 months after planting.

ANNEX B

Soils--Nine soil groups have been identified. The soil classification system used for the Soil Map of Africa (D'Hoore, 1964) is used for the descriptions of the soils. Technical descriptions of 153 Zambian soil profiles are given in Soil Survey Reports No. 6 and No. 11. The main soil groups are red clays sandveldt soils, Barotse soils, black clays, Kafue alluvium, floodplain soils, dambo soils, valley soils, and rock and rubble.

General descriptions and profile characteristics of the major soil groups are cited below. The profile numbers refer to sites identified on the map. The analysis of these profiles reflects the soil-forming factors.

1. Red Clays--These are typical well-drained soils over limestone and other basic rocks. They mainly have a dark red color in both the topsoil and subsoil. Moderately well to imperfectly drained soils are browner or have brown, yellow, and grey mottles at some depth in the subsoil. These soils range in texture from sandy clay loam to clay in the topsoil but have a clay texture in the subsoil. They are often deep but some limestone soils have occasional to many rock outcrops, and some soils over basic igneous rocks (such as basalt, gabbro, etc.) have weathering rock or rock boulders at a moderate or shallow depth. Some soils have quartz gravel or laterite in the subsoil.

Profile No. 7

Soils reference: Red clays.

Classification: Ferruginous tropical soils (Fersiallitic) (Jb).

Location: Near Lukuzye, Eastern Province.

Topography: Gently sloping, slope 2%.

Parent material: Biotite schist.

Annual rainfall: 40 in.

Description:

Ap	0-6 in, dark reddish brown (2.5YR 3/4) fine sandy loam; moderate, fine, subangular blocky structure; hard when dry.
B21t	6-18 in, dark red (2.5YR 3/6) sandy clay loam; strong, fine, subangular blocky structure; hard when dry.
B22t	18-48 in, red (2.5YR 4/6) sandy clay; faint yellowish red mottling; weak, fine, subangular blocky structure; very hard when dry.

1a. Red Brown Loams--These, which are shown separately on the Soil Map of Zambia, are like the red clays in most of their properties but they have a lighter topsoil texture (usually sandy loam) and usually a lighter subsoil texture as well (sandy clay loam or sandy clay). They are mainly developed over granites or gneisses which contain relatively large amounts of dark-colored minerals (such as black mica, hornblende, augite, etc).

Profile No. 11

Soils reference: Red brown loams.

Classification: Ferrisols (Kb).

Location: Near Katete, Eastern Province.

Topography: Gently sloping--slope 1%-2%.

Parent material: Altered limestone, possibly calcsilicate.

Annual rainfall: 40 in.

Description:

A1	0-7 in, dark redish brown (5YR 3/4) sandy loam; weak, fine, subangular blocky structure; slightly hard when dry.
B21	7-22 in, dark reddish brown (2.5YR 3/4) sandy clay loam; weak, coarse, subangular blocky structure; hard when dry.
B22	22-38 in, dark red (2.5YR 3/6) sandy clay loam; weak, coarse, subangular blocky to massive; hard when dry.

B23 38 in, thin band of quartz rubble over slightly weathered large boulder on one side of the pit. Soil extends to more than 48 in on the other side.

Profile No. 8

Soils reference: Red brown loams.

Classification: Ferruginous tropical soils (Fersialitic) (Jb).

Location: Near Magoye, Southern Province.

Topography: Near level plain.

Parent Material: Biotite schist.

Annual rainfall: 31 in.

Description:

Ap 0-6 in, dark brown (10YR 3/3) loamy fine sand; structureless; slightly hard when dry.

B1 6-16 in, yellowish red (5YR 4/6) fine sandy clay loam; weak, fine, subangular blocky structure; hard when dry.

B21 16-32 in, dark red (2.5YR 3/6) fine sandy clay; strong, fine, subangular blocky structure; hard when dry.

B22 32-60 in, red (2.5YR 4/6) fine sandy clay; weak, fine, subangular blocky to massive; slightly hard when dry.

Profile No. 9

Soils reference: Red brown loams.

Classification: Ferruginous tropical soils (Fersialitic) (Jd).

Location: Near Kombe, Central Province.

Topography: Nearly level.

Parent material: Limestone.

Annual rainfall: 35 in.

Description:

Ap 0-12 in, dark reddish brown (5YR 3/4) fine sandy clay; weak, fine, subangular blocky structure; hard when dry.

B21 12-36 in, reddish brown (5YR 4/4) clay; strong, fine, subangular blocky structure; hard when dry.

B22 36-60 in, dark red (2.5YR 3/6) clay; strong, fine, subangular blocky structure; hard when dry.

Remarks: At 60 in a thin horizon of quartz gravels and stones over limestone.

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1b. Moderately Leached Red Clays and Red Brown Loams--In the south of the country, roughly south of the 1,000 mm annual rainfall line, the red soils are mainly slightly to medium acid in reaction and contain relatively large amounts of weatherable or soluble minerals. They differ noticeably from the strongly leached red soils in having a heavier, more sticky, kind of clay which cracks into small blocks in the subsoil when the soils are dry. This type of clay has a large capacity to hold nutrients compared with clays found in other well-drained upland soils in Zambia.

These are very fertile and productive soils (where not spoilt for agriculture by frequent rock outcrops or the presence of sheet laterite near the surface). Nonetheless, they require normal use of fertilizer to produce high crop yields under conditions of continuous cropping. However, fertilizers are less likely to be leached from these soils during spells of heavy rainfall than happens in sandveldt soils and liming is rarely needed.

Maize is the main crop grown on these soils, and high yields can be obtained under good management. Cotton and burley tobacco are also important crops in some areas and these soils provide good pastures.

Profile No. 16

Soils reference: Leached red brown loams.

Classification: Ferrallitic (Lc).

Location: Near Kawambwa, Luapula Province.

Topography: Gently sloping, slope 1%-2%.

Parent material: Sandstone.

Annual rainfall: 51 in.

Description:

A1	0-6 in, dark brown (7.5YR 3/2) sandy loam; weak, fine crumb structure; friable when moist.
B1	6-15 in, brown (7.5YR 4/4) sandy clay loam; weak, fine crumb structure; friable when moist.
B21	15-27 in, strong brown (7.5YR 5/6) sandy clay; weak, fine subangular blocky structure; friable to firm when moist.
B22	27-100 in, yellowish red (5YR 5.8) sandy clay; weak, very fine subangular blocky or crumb structure; friable when moist.

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Profile No. 18

Soils reference: Leached red clays.

Classification: Ferrallitic (Ln).

Location: Near Bancroft, Western Province.

Topography: Nearly level.

Parent material: Limestone.

Annual rainfall: 47 in.

Description:

A1 0-7 in, weak red (10R 4/3) sandy clay loam; weak, fine, subangular blocky structure; loose when dry.

B1 7-18 in, dark red (10R 3/6) sandy clay loam; weak, fine, subangular blocky structure; friable when moist.

B21 18-48 in, dark red (10R 3/6) clay; massive; friable when moist.

B22 48-60 in, dark red (10R 3/6) clay; massive; friable when moist.

The red clays are rather heavy for ox cultivation both when dry and wet. In wet periods they can be too sticky to cultivate by machinery so that weed control can provide a problem. Cultivation by machines, when too wet, compacts the topsoil causing water to stand in the plant rows thus damaging crops such as maize, cotton, and tobacco which do not tolerate waterlogged conditions.

The red brown loams are better soils in all these respects. However, under continuous cultivation the topsoil structure can break down, making the soils hard when dry and susceptible to erosion by heavy rainfall. On both the red brown loams and red clays, erosion can take place on quite gentle slopes where large fields are cultivated, and soil conservation practices need to be followed to control runoff.

1c. Strongly Leached Red Clays and Red Brown Loams--These soils are developed over similar rocks to the moderately leached red soils but under conditions of higher rainfall which has led to deep weathering and strong leaching. The red clays are developed extensively over limestone in the northwestern and copperbelt provinces, over small patches of other basic rocks elsewhere in the granites and gneisses containing basic minerals (such as black mica, hornblende, etc.), and possibly over some sandstones containing such minerals too.

Like the moderately leached soils, these soils usually appear red or reddish brown in both the topsoils and subsoils. They differ noticeably from

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the other soils in having a friable type of clay which does not crack strongly when dry. Even where clay contents are very high, as in soils over limestone, the subsoil feels loamy when moist and dry. The soils are strongly or very strongly acid to great depth, and their clay has a low capacity to hold nutrients. Even so these soils usually contain slightly more calcium and magnesium than strongly leached red sandveldt soils.

Soils transitional to moderately leached red clays occur in the south of the Copperbelt province near Mpongwe (and presumably elsewhere). They differ from soils further north in showing a tendency to crack into small blocks when dry as well as in being less acid and in having higher contents of calcium, etc. Transitional soils also occur over hard basic rocks near Mpika, Ngoli, and Mbala in northern province and north of Solwezi in northwestern province.

The red soils are the best soils occurring in the northern half of the country. Best of all are the small patches of incompletely weathered and leached red soils over hard, very basic, rocks and the transitional soils referred to above. The main advantage of the red soils over other leached soils is their high iron content which binds the soil particles together into particles like sand, making the soils more permeable and more resistant to erosion. They are, therefore, more suitable for large-scale cultivation than the more widespread sandveldt soils.

Liming is needed on some of the soils to correct the strong acidity, and heavy use of fertilizers is required to obtain good crop yields. Maize, pineapples, tea, and other tree crops are suitable for the soils, and groundnuts and beans can be grown where acidity has been sufficiently corrected. Good pastures can be grown under good management, including heavy use of nitrogen and phosphorus.

Profile No. 19

Soils reference: Leached red brown loams.

Classification: Ferrallitic (Ln).

Location: Near Kawambwa, Luapula Province.

Topography: Broad, very gently sloping ridge, slope under 1%.

Parent material: Shale or mudstone.

Annual rainfall: 51 in.

Description:

A1 0-5 in, dark reddish brown (5YR 3/3) fine sandy clay loam; moderate, fine crumb structure; friable when moist.

B1 5-13 in, reddish brown (5YR 4/4) fine sandy clay; weak, fine subangular blocky structure; very friable when moist.

B21 13-29 in, yellowish red (5YR 5/6) sandy clay; weak, very fine subangular blocky or crumb structure; very friable when moist.

B22 29-100+ in, yellowish red (5YR 5/8) sandy clay; weak, very fine subangular blocky or crumb structure; very friable when moist.

2. Sandveldt Soils--Sandveldt soils are of various kinds. They have in common a sandy topsoil overlying a more clayey subsoil. (Sandveldt soils over Barotse sands in the Livingstone-Kalomo-Namwala area are described below with the Barotse sands soils of group 3).

The thickness of the sandy topsoil varies in different soils and so does the texture of the subsoil, which ranges from loamy sand to sandy clay in different soils. In most soils there is a gravel layer in the subsoil. This varies in thickness and depth sometimes within short distances. Laterite often occurs in a narrow strip bordering dambos and more erratically on upland sites. Rock outcrops occur in some soils.

Sandveldt soils are mainly well to moderately well drained. They are usually dark grey to brown in the topsoil depending on the content of organic matter. The subsoil ranges from yellowish red to yellowish brown in different soils. It is typically friable and porous but some cultivated soils have a rather compact subsoil. The zone of weathered or weathering rock below 1-2 m is usually mottled red and yellow. Some soils that are imperfectly drained have paler colors than described above and usually have mottles or laterite in the subsoil.

Sandveldt soils vary in fertility and agricultural value. Four subgroups have been recognized as listed in Table 1. They are described separately below.

2a. Moderately Leached Sandveldt Soils--In the southern, central, and eastern provinces typical sandveldt soils are only medium acid and hold nutrients farily well under moderate rainfall conditions. Except where they occur on moderate slopes or are very gravelly within the upper 40 cm, they generally provide good agricultural soils. They are especially suitable for Virginia tobacco. Maize and other crops requiring good drainage can also be grown

satisfactorily. They respond well to use of fertilizers, especially nitrogen. Cultivation of these soils is generally easier than on adjoining red clay soils, expecially in wet years but some become very hard when dry.

The main problem on these soils are drought, if the rains are late, interrupted, or finish early; the risk of erosion if soil conservation practices are not used; and rapid leaching of nitrogen during periods of heavy rainfall so that additional fertilizer topdressings may be needed.

There are other sandveldt soils in the central province (and probably in the southern and eastern provinces as well) which are identical in appearance to the soils described above but which are strongly or very strongly acid in reaction and have a low capacity to retain nutrients. These soils are strongly leached sandveldt soils and are described below. Also present in the central province, and possibly in the southern and eastern provinces, are sandveldt soils with a white sandy topsoil. These are bleached sandveldt soils described below in subgroup 2c.

Profile No. 12

Soils reference: Sandveld.

Classification: Ferrisols (Kc).

Location: West of Broken Hill, Central Province.

Topography: Nearly level plain.

Parent material: Schist.

Annual rainfall: 36 in.

Description:

A1	0-3 in, very dark greyish brown (10YR 3/2) fine sand; weak, fine, crumb structure; soft when dry.
A3	3-17 in, brown (10YR 4/3) loamy sand; structureless; soft when dry.
B1	17-30 in, strong brown (7.5YR 5/6) sandy loam; weak, medium, subangular blocky structure; slightly hard when dry.
B21	30-48 in, yellowish red (5YR 5/6) sandy clay loam; weak, medium, subangular blocky structure; hard when dry.
B22	48-72 in, yellowish red (5YR 5/8) sandy clay loam; strong, fine, subangular blocky structure; hard when dry; few, thin, patchy coatings on peds.

Profile No. 13

Soils reference: Sandveld.

Classification: Ferrisols (Kc).

Location: Near Choma, Southern Province.

Topography: Gently sloping, slope 1.5%.

Parent material: Granite.

Annual rainfall: 32 in.

Description:

A1	0-7 in, brown (10YR 4/3) medium to coarse sand; structureless; very friable when moist; very numerous fine grass roots.
C1	7-13 in, yellowish brown (10YR 5/6) medium to coarse sand; structureless; very friable when moist; numerous grass roots.
C2	13-27 in, strong brown (7.5YR 5/6) medium to coarse sandy loam, structureless; very friable when moist; fairly numerous grass roots.
C3	27-50 in, strong brown (7.5YR 5/6) sandy loam; massive; slightly hard when dry.

2b. Strongly Leached Sandveldt Soils--These soils occupy most of the northwestern, Copperbelt, Luapula, and northern provinces where the annual rainfall exceeds 1,000 mm. They are developed over all kinds of rock except limestone and other kinds of basic rock. Dark-colored chipya soils are described separately in subgroup 2d. Strongly leached soils also occur over some quartzites and basement complex gneisses in the central province and probably also in the southern and eastern provinces.

These soils are very strongly acid. The clay is of a type which has a low capacity to hold nutrients, and soil nutrient reserves are very low. Many soils in the south are gravelly but even where the soils are deep, as they generally are in the northern half of the country, these are poor agricultural soils. Liming is needed to correct acidity if a permanent system of arable cropping is to be substituted for the traditional methods of shifting cultivation practiced at present. Heavy use of nitrogen and other fertilizers will be needed in order to maintain good crop yields. These soils are as susceptible to erosion as most other sandveldt soils if soil conservation practices are not used.

In the south soils deep and level enough to be cultivated can be used for Virginia tobacco, maize, and other crops requiring good drainage. Good yields can be obtained with heavy use of fertilizers and use of lime to correct acidity.

In the north the more cloudy and humid environment makes conditions less suitable for Virginia tobacco and maize, although both crops can be grown. Pineapples and some fruit trees grow well where irrigation can be provided and so do coffee and tea on deep soils. Pasture improvement by reseeding, use of fertilizers, and irrigation, where available, is also possible for dairy farming near large urban areas. In general, however, the strongly leached sandveldt soils in the north must be regarded as poor soils with a lower economic potential than the moderately leached soils in the south. In areas remote from roads, markets, and fertilizer supply centers, forestry and ranching are the most suitable uses for these soils.

2c. Bleached Sandveldt Soils--These soils differ from other sandveldt soils in having an upper soil layer which appears white when dry. Under woodland the surface layer may be dark grey because of humus staining but plowed fields appear white when dry. These soils occupy some almost level upland areas. They have been seen near Kabwe and other places in the central province but their actual extent is not yet known, nor is the type of rock over which they are developed.

Profile No. 17

Soils reference: Leached sandveldt.

Classification: Ferrallitic (Lc).

Location: Near Kasama, Northern Province.

Topography: Gently sloping, slope 1%-2%.

Parent material: Sandstone.

Annual rainfall: 50 in.

Description:

A1	0-6 in, dark brown (7.5YR 3/2) loamy sand; structureless; soft when dry.
B21	6-18 in, brown (7.5YR 4/4) sandy clay loam; weak, very fine subangular blocky or crumb structure; friable when moist.
B22	18-60 in, strong brown (7.5YR 5/6) sandy clay loam; weak, very fine subangular blocky or crumb structure; friable when moist.

Profile No. 20

Soils reference: Leached sandveld.

Classification: Ferrallitic (Ln).

Location: Near Mufulira, Western Province.

Topography: Gently sloping, slope 1%-2%.

Parent material: Biotite schist.

Annual rainfall: 50 in.

Description:

Ap	0-6 in, dark brown (7.5YR 3/2) fine sandy loam; structureless; friable when moist.
B1	6-20 in, yellowish red (5YR 5/6) fine sandy clay loam; weak, medium subangular blocky to very fine crumb structure; friable when moist.
B2	20-60 in, yellowish red (5YR 4/6) fine sandy clay loam; weak, very fine subangular blocky structure; friable when moist.

The bleached sandy topsoil varies from a few centimeters thick on moderately well-drained sites to as much as 50-100 cm thick on imperfectly to poorly drained sites. In the more poorly drained soils there is usually weak yellow mottling in this layer. The sandy upper layer overlies a sandy clay loam to clay lower layer, sometimes abruptly. This layer is friable and porous but the abrupt change in texture causes a relative impedance of drainage. Moderately well-drained soils are yellowish red (orange) in this layer but overlie a red and yellow mottled layer at 1-2 m. Imperfectly and poorly drained soils are yellowish brown to grey in this layer and strongly mottled. As in other sandveldt soils a gravel layer occurs at a variable depth in these soils and hard laterite occurs in some.

These soils resemble moderately leached sandveldt soils in their nutrient properties. They differ from them in being less well drained. Despite the impeded drainage they often seem to be used for Virginia tobacco and maize, although yields of these crops must be reduced in wet years. Cultivation of crops on ridges helps to improve drainage. The areas in which these soils occur are so flat that provision of an external drainage outlet is difficult, at least for the individual farmer. Nonetheless, the topsoils have very weak structure which causes the surface layer to form a cap and there can be local erosion within fields if careful conservation practices are not followed.

2d. Chipya Soils--Chipya is a vegetation type occurring mainly in high rainfall areas. It is particularly widespread in the Luapula Valley. The name is given to very tall grassland, sometimes with bracken (fern), which burns so fiercely that few trees remain.

Chipya vegetation can occur on clays but the term "chipya soil" is usually applied to strongly leached sandveldt soils which have a black or very dark brown color to a depth of 50-100 cm or more. This color seems to be due to ash from the burnt vegetation, not to a high content of humus. The soils are very strongly acid and very low in plant nutrients. The opinion of the DGS survey team which made a broad reconnaissance soil survey of the northern and Luapula provinces was that, on balance, chipya soils were slightly less fertile than the surrounding, strongly leached sandveldt soils.

In some areas chipya soils remain uncultivated. In other areas, including the Luapula Valley, they are widely used for cassava. This is a crop which is tolerant of poor sandy soils (although it produces better yields on good soils). For maize, sorghum, groundnuts, and beans to be grown satisfactorily, liming would be necessary as well as relatively heavy use of nitrogen and other fertilizers. Tree crops can be grown if protected from fire and adequately fertilized, among them, oil palms and mango in the Luapula Valley.

3. Barotse Sands--The Barotse sands are treated as one unit on the Soil Map of Zambia. In fact they include several distinct kinds of soil. The differences are partly due to differences in the mineral composition of the sands in different areas, partly to differences in climate, and in some cases perhaps, partly due to differences which developed under past climatic conditions.

The six major kinds of soil now recognized are described below. More detailed descriptions are given in Soil Survey Report No. 11. The 1973 soil map of the western province shows the distribution of the major soils within this province. This is still a highly generalized map. No equivalent map is yet available for Barotse sands areas of the northwestern and southern provinces but the Barotse sands are known to be much less extensive in Mwinilunga district than is shown on the Soil Map of Zambia.

3a. Moderately Leached Red Soils--These are red or reddish brown soils, mainly deep sands, but also including some soils with loamy sand to sandy clay loam texture in the subsoil. They are slightly to medium acid and have moderate contents of calcium, magnesium, etc.

These soils occur in a narrow strip along the edge of the Zambezi Valley between Senanga and Seheke and near the Kabompo River in Lukulu district. Small patches occur along the Luena Valley (as near Mangango) and elsewhere but much less extensively than is suggested by the areas with symbol "K6" on the Soil Map of Zambia. Some red sands in the Kabompo and Livingstone-Kalomo areas may be of this type also.

These soils are well drained to excessively drained. They are easy to cultivate and they permit great freedom of root development. The risk of erosion is small unless very large fields are cleared on sloping soils in which case conservation banks should be made.

Maize, Virginia tobacco, groundnuts, cassava, and fruit trees are suitable crops. Good yields can be obtained with normal use of fertilizers and liming is not necessary (unless acidifying fertilizers such as ammonium sulfate are used for several years). Maize and tobacco are less suitable crops south of Senanga because of the lower rainfall and sorghum and bulrush millet are more reliable cereals for this area. North of Senanga additional topdressings of nitrogen may be needed after periods of heavy rainfall to replace nitrogen lost by leaching.

Although only moderate to poor soils by national standards (because of drought in the south and rapid leaching of nitrogen in the north), these are the best upland soils occurring in the Barotse sands area. For this reason they deserve special attention by extension workers to ensure that good agricultural practices are followed so that the best use is made of this valuable but limited resource.

3b. Strongly Leached Red Sands--This subgroup includes red to dark brown sands which differ from the soils of subgroup 3a in being strongly or very strongly acid in reaction throughout the profile and in having very low nutrient contents. Some have white sand grains in the topsoil like the podzolic soils and podzols described in subgroups 3d and 3e.

These soils occur on the high ridges adjoining the Zambezi Valley near Mongu, Kalabo, and for some miles south of Senanga. They also occur on the plateau edge between Seshcke and Mulobezi and in small patches in the interior of the Barotse sands (although less extensively than is suggested by unit "Ke" on the Soil Map of Zambia). Possibly some of the red sands in the Kabompo and Livingstone-Kalomo areas are of this type.

Except where they occur within forest reserves, these soils are usually intensively farmed. Cassava is the main crop together with some bulrush millet. Cultivation is easy and the risk of erosion slight. They are poor soils, however, better suited for tree crops and cassava than for the usual arable crops. Liming and heavy use of fertilizer would be necessary for groundnuts, maize, Virginia tobacco, and cotton for which they are physically well suited but the economics of such practices on these droughty and easily leached soils need to be calculated. In local practice the best yields are obtained from small fields on which cattle have been kraaled or staked to concentrate their manure.

3c. Yellow Soils--These soils occur extensively in the east of Kaoma district and locally on valley slopes elsewhere. They have also been seen between Chizela and Manyinga in northwestern province. In the latter area and in the east of Kaoma district the soils have a greyish brown sandy topsoil which grades into a yellowish brown subsoil ranging from loamy sand to sandy clay loam in different soils. In some deep expsoures sandy clay loam material has been seen continuing to 3 m without change. Very faint grey and brown mottles occur in some soils below 1-2 m and laterite commonly occurs along dambo margins.

These soils mainly occupy almost level upland areas. They also occur on valley slopes in areas of more rolling relief. Their yellow color and the presence of faint mottles in some soils suggests that most of them are only moderately well drained. They are no more than medium acid and contain moderate amounts of calcium, magnesium, etc.

Except for a few miles around Kaoma town these soils are little farmed. This may be partly due to lack of surface and well water for people to use in these areas and partly to the presence of tsetse fly and game near the Kafue National Park. The soils are easy to cultivate but have an unstable topsoil structure, which may cause problems from capping and local erosion within fields. The soils need to be managed so as to maintain a good crop cover and as much organic matter as possible in the topsoil.

Maize and Virginia tobacco are being grown successfully on the Kaoma TBZ scheme, although it remains to be seen whether satisfactory crops are obtained in years of above-average rainfall when the water table might be high. Groundnuts, sweet potatoes, sorghum, bulrush millet, and cassava are also suitable crops. Good yields can be obtained under good management including normal use of fertilizers. Liming is not necessary when the soils are newly cleared. However, the topsoils are easily leached and liming could eventually become necessary to correct acidity in repeatedly cultivated soils.

Profile No. 14

Soils reference: Barotse sands.

Classification: Ferrallitic (La).

Location: Near Mongu, Barotse Province.

Topography: Nearly level plain.

Parent material: Sandstone.

Annual rainfall: 33 in.

Description:

A1 0-3 in, dark brown (10YR 3/3) medium to coarse sand; structureless; loose when dry or moist; numerous grass roots.

C1 3-12 in, brown (10YR 5/3) medium to coarse sand; structureless; loose when dry or moist; fairly numerous grass roots.

C2 12-70 in, pale brown (10YR 6/3) medium to coarse sand; structureless; loose when dry or moist; few roots.

Profile No. 15

Soils reference: Barotse sands.

Classification: Ferrallitic (La).

Location: Near Namwala, Southern Province.

Topography: Nearly level plain.

Parent material: Sandstone.

Annual rainfall: 31 in.

Description:

A1 0-6 in, dark brown (10YR 3/3) fine sand; structureless; loose when dry or moist.

C1 6-38 in, brown (10YR 5/3) fine sand; faint, patchy dark brown staining; structureless; loose when dry or moist.

C2 38-80 in. light yellowish brown (10YR 6/4) fine sand; faint, patchy, yellowish brown staining; structureless, soft when dry.

3d. Podzolic Soils--These soils are named for their similarity in their surface layers to the podzols, the soil group described next. Both kinds of soils have white sand on the ground surface and the topsoil appears very dark grey, although is actually consists of a mixture of white sand and black organic particles. The soils differ noticeably from each other in the subsoil. Whereas the podzols have a dark-colored subsoil, the podzolic soils have pale brown or

pale yellowish brown sand below 10-40 cm. This continues to great depth becoming weakly mottled yellow brown below 2-4 m in most upland soils but at less than 1 m in some dambo-edge soils.

The two soils differ in reaction. Whereas the podzols are extremely acid in the topsoil, the podzolic soils are only medium to strongly acid in this layer. They are strongly or very strongly acid in the subsoil.

The description above applies to podzolic soils which occupy most of the Barotse sands area east of the Zambezi. Similar soils are believed also to occur widely west of the Zambezi on very low ridges rising above the sandplain soils of subgroup 3f. In both areas the relief is almost level and dambos are few and far apart. It seems probable that these soils are wet in years of high rainfall but this needs to be confirmed.

Podzolic soils developed in colluvial and terrace deposits east of Seshcke, as shown on the soil map of the western province, have rather different properties from podzolic soils developed directly in the Barotse sands. They are described below as brown podzolic soils, subgroup 8b, together with valley soils.

The Barotse sands soils remain almost entirely under woodland. The reason for the lack of cultivation is not entirely clear. Certainly they are very poor agricultural soils with low nutrient contents and a low capacity to hold both nutrients and moisture. Lack of surface water for domestic use could also have prevented settlement. Bulrush millet, cassava, and Bambarra groundnuts are the main crops grown where the soils are cultivated.

Podzolic soils have a low agricultural potential. They would be expensive to fertilize (and eventually to lime) in order to produce crops made uncertain by droughtiness during dry spells and possibly by waterlogging in years of high rainfall. Use of kraal manure is recommended, where this can be provided, to produce subsistence crops of maize, sorghum, millet, groundnuts, etc., around the few settlements that exist. These soils support only a sparse natural grass cover so prospects for cattle grazing are poor. Utilization for natural forest products seem the most likely prospect for many years to come.

3c. Podzols--Podzols are soils in which either iron, aluminum, humus, or any combination of these constituents has been washed out of the topsoil and deposited in the subsoil. Such soils are extensively developed in the north of Europe and America but they are not common in the tropics, especially in areas with a pronounced dry season. Such soils occur extensively to the east of

Mongu and in parts of the northwestern province. In the case of the Zambian soils, it is humus which has moved from the topsoil to the subsoil, possibly together with some aluminum but with very little iron.

These soils occupy almost level upland areas. In the western province the soils are interrupted by many circular dambos and by the Luena Flats. The soils appear to be well drained.

These soils appear white on the ground surface. The topsoil is 20-50 cm thick and appears dark grey but it actually comprises a mixture of white sand and black organic particles. In most soils this layer is underlain to a depth of 1 m or more by dark greyish brown, weakly humus-stained sand. This eventually grades into pale brown or yellow sand which has weak yellow-brown mottles below 2-3 m. In some soils the topsoil is underlain by a layer of white sand and then by dark brown sand at 1-2 m or more.

These are probably the most infertile soils in Zambia. They are extremely acid in the topsoil (and in the white subsoil layer where this exists). Lower layers are very strongly or strongly acid. Nutrient reserves are extremely low, and the soils have a very low capacity to hold both nutrients and moisture.

Most of these soils remain under natural woodland. Near Mongu and along the edge of cultivated dambo soils, poor crops of cassava and bulrush millet are grown around settlements. The soils are also used to provide poor grazing for cattle in these areas at the time when the adjoining Zambezi floodplain is flooded. The grass cover is very sparse, and the animals lose weight when kept on these soils.

Use of fertilizers seems unlikely to be economic on these easily leached soils, except perhaps on small fields where fertilizers might be used to supplement manure provided by cattle kraaling. As on the podzolic soils, utilization for natural forest products seems the most likely prospect on these soils for many years to come or at least until such time as the use of slow-release fertilizers might become economic.

31. Hydromorphic Soils--Hydromorphic soils are soils whose properties have developed as a result of wetness. Barotse sand soils of this kind include the wet Litonge and dry Litonge soils occurring along the edges of the upper Zambezi floodplain and neighboring dambos, also sandplain soils occurring extensively west of the Zambezi and locally in the north of the northwestern province. Dambo soils, which are also hydromorphic soils, are described as a separate group (group 7).

The sandplain and Litongo soils have topsoils that are almost black to a depth of 30-100 cm or more. Below this there is pale brown to grey sand, which is mottled yellow or red in some sandplain soils.

The wet Litongo soils, and some sandplain soils in the northwestern province, are almost peaty in the surface layer. The dark color of lower layers in these soils, and of the whole topsoil in dry Litongo soils and other sandplain soils, is due to organic staining and possibly mixture with ash from seasonal grass fires but the actual content of organic matter is low. All the soils are strongly to extremely acid, and their nutrient-holding capacity is contained entirely in their topsoil organic matter.

The reputed fertility of the Litongo soils is based more on their favorable moisture properties than on a high nutrient content. In effect the Litongo soils benefit from subsurface irrigation provided by water seeping out of adjoining upland areas of Barotse sands. Most of these soils probably benefit also from manuring by household refuse, crop residues, and in the case of some dry Litongo soils, kraal manure.

Wet Litongo soils are used intensively, especially for early maize, harvested before the Zambezi floods arrive in January-February. Many minor crops, including vegetables, bananas, and sugarcane are also grown. Surface ditches or raised beds are used to improve drainage. Dry Litongo soils in which the water table is deeper are used for fruit trees, cassava, and wet-season subsistence crops. Sandplain soils are only cultivated on small patches enriched by kraaling or staking of cattle close to settlements. They are widely used for dry-season grazing. This is of sour dambo type and of poor quality.

The productivity of the Litongo soils, especially wet Litongo soils, could be increased by use of fertilizers, improved crop varieties, and plant protection measures. As much organic matter as possible should be provided to dry Litongo soils (by use of kraal manure or compost) to provide a better capacity to hold nutrients applied as fertilizers. Research is needed to improve the quality of grazing provided by the sandplain soils.

4. Black Clays--This group includes two units shown on the Soil Map of Zambia: Kafue clays, and Solonetzic grey clays and sandy clays. It also includes many areas of black clay dambo soils tooo small to show on the scale of this map. Black clays occurring on the upper Zambezi flodplain are described in subgroup 6a.

The black clays are distinctive soils. Their most characteristic property is their heavy clay texture, which causes them to crack widely when dry and become very sticky and plastic when wet. They are mainly black or dark grey but some are a yellowish brown (olive). Many contain lime nodules at a variable depth in the subsoil.

These soils are poorly drained. Most become very wet during the rainy season. Some on the Kafue Flats are flooded to a depth of 1-3 m by the end of the rainy season.

Another characteristic feature of the black clays is their irregular surface relief (known by the Australian term "gilgai"). This consists of a series of small ridges standing 20-60 cm above circular depressions about 2-7 m in diameter.

The soils in the gilgai depressions are usually black and have no lime nodules down to a meter or more. They crack more widely than the ridge soils sometimes with large holes where the soil has collapsed. They lie wet or flooded longer than the ridge soils also.

The gilgai ridge soils are often browner in color than the depression soils, especially in the subsoil. Lime nodules usually occur within 1 m of the ground surface. The soils dry out more quickly than the depression soils.

These differences, occurring within a few meters of each other, provide complex soil patterns. This can often be seen in ditches or excavations made in these soils where the differences in color and in the depth to the lime layer may stand out prominently. The differences are due to the way in which these clays swell when rainwater enters the deep cracks and wets the lower soil layers before the upper layers. If the subsoil is examined, the faces of large soil blocks are seen to be shiny as though polished. This is where the blocks have pressed and slipped against each other while swelling. These shiny surfaces are called "slickensides." They are characteristic for this kind of soil.

Chemically these soils are very rich. Their clay is of a type with a large capacity to hold nutrients. The soils are often neutral to alkaline in reaction throughout but some have a strongly acid topsoil. There are large amounts of calcium and magnesium and most soils contain lime at some depth in the subsoil. Some contain gypsum as well.

Utilization of this high fertility is limited by the difficult physical properties. Many are too wet to be cultivated during the rainy season. Even where they are not too wet, plowing is made difficult by the very hard state

of the soils when dry and the very sticky condition when wet. Where they can be drained and cultivated with heavy equipment, they can be highly productive soils for such crops as sugarcane (with irrigation). They are soils better suited for large-scale than for small-scale management. Most of these soils are used at present only for dry-season grazing.

Profile No. 4

Soils reference: Kafue clays.

Classification: Vertisol (Dj).

Location: Kafue Flats, Southern Province.

Topography: Nearly level, slight gilgae micro relief.

Parent material: Lacustrine deposit.

Annual rainfall: 32 in.

Description:

A1	0-3 in, very dark grey (10YR 3/1) clay; weak, fine subagnular blocky structure, very hard when dry; numerous grass roots.
C1gca	3-30 in, dark grey (5Y 4/1) clay; weak, coarse, subangular blocky to massive; many slickensides; very hard when dry; few, hard calcium carbonate concretions.
C2ca	30-60 in, olive grey (5Y 4/2) clay; massive, very firm when moist; common, hard calcium carbonate concretions.

Profile No. 21

Soils reference: Solonetzic grey clays and sandy clays.

Classification: Halomorphic soils (Ma).

Location: Luangwa Valley South Game Reserve, Eastern Province.

Topography: Nearly level.

Parent Material: Sandy alluvium.

Annual rainfall: 30 in.

Description:

A1	0-8 in, very dark greyish brown (10YR 3/2) medium grained loamy sand; structureless; hard when dry.
A2	8-24 in, yellowish brown (10YR 5/4) medum to coarse grained loamy sand; slightly hard when dry.
B2	24-48 in, very dark greyish brown (10YR 3/2) medium grained sandy loam; weak, coarse, subangular blocky structure; very hard when dry.

Several different soils series will eventually need to be recognized within the black clays group. Dambo black clays are already separated from those developed in Kafue alluvium. Within the Kafue alluvial clays, separation is possible into mopane clays badly affected by sodium (and sometimes by salts), nonsodic soils with lighter textured and strongly acid topsoils, and those in young river alluvium which have not yet become calcareous or developed strong cracking properties.

Similar subdivisions probably occur on the Simuiaha Flats west of Livingstone (shown on the Soil Map of Zambia as "Solonetzic grey clays and sandy clays") but the proportion of sodium-affected soils under mopane woodland is apparently higher here. (Black mopane clays occurring in the Luangwa Valley are described in subgroup 6b below and included with "Valley Soils" on the Soil Map of Zambia. Mopane clays occurring in the Gwembe Valley are described in subgroup 8C.)

Profile No. 22

Soils reference: Solonetzic grey clays and sandy clays.

Classification: Halomorphic soils (Ma).

Location: Luangwa Valley South Game Reserve, Eastern Province.

Topography: Nearly level.

Parent material: Mudstone.

Annual rainfall: 30 in.

Description:

A1 0-4 in, dark brown (7.5YR 3/2) sandy clay loam; strong subangular blocky structure; very hard when dry, glossy surfaces on peds; many water-rounded pebbles.

B21 4-12 in, dark brown (7.5YR 4/4) clay, strong, prismatic and subangular blocky structurep; very hard when dry; clay coatings on ped surfaces.

B22 12-48 in, dark brown (7.5YR 4/2) clay; moderate, subangular blocky structure; very hard when dry.

5. Kafue Basin Alluvium--This unit is an example of a soil association. It occurs on the north side of the Kafue floodplain below the Itezhitezhi Dam site and was mapped during the FAO survey of the Kafue Basin in 1963.

The association consists of long sandy ridges standing from 1 to 15 m above depressions which have more clayey soils. The ridges have excessively well-drained soils. The depression soils are imperfectly drained and become wet in the subsoil during the rainy season. Both soils are strongly acid and of low agricultural value. The association includes minor areas of better soils suitable for cultivation.

The main soils on the ridges have a dark greyish brown sandy topsoil which grades at about 40 cm into a brown to reddish brown subsoil. This usually continues to 3 m or more without gravel or rock being met. In some soils the whole of the subsoil has a texture of sandy clay loam. In others loamy sand continues to more than 1 m before grading into sandy loam or sandy clay loam. Both soils are porous and friable, rapidly permeable, and have a low moisture holding capacity in the upper layers. They are strongly or very strongly acid and have a low content of plant nutrients.

Most of these soils occur under dense thicket. The few cultivated patches near the Kafue River produce subsistence crops of maize, groundnuts, and vegetables. These are poor agricultural soils, with little potential for agricultural development, either with or without irrigation. If development is required areas of soils have sandy clay loam texture at 15-40 cm should be selected by detailed soil survey.

The main soils in depressions have a dark greyish brown topsoil which is sandy near the surface and grades into sandy loam at 10-15 cm. The subsoil below about 30 cm is a pale brown friable sandy clay loam to clay with many red mottles. This material normally continues to 2-3 m becoming greyer with depth but hard laterite occurs in some soils at between 1 and 2 m. There are small areas of somewhat better-drained soils which have yellow brown subsoils with weaker mottling.

These depression soils are strongly or very strongly acid. They are fairly well provided with plant nutrients but their suitability for agriculture is limited by the fact that they become wet in the rainy season. Some areas of better-drained soils are cultivated for subsistence crops but the greater part of the soils remains under woodland.

Profile No. 3

Soils reference: Kafue basin alluvium.

Classification: Juvenile soils (Bo).

Location: Mwembeshi River, Central Province.

Topography: Nearly level floodplain.

Parent material: Recent alluvium from mixed source.

Annual rainfall: 32 in.

Description:

Ap 0-5 in, very dark greyish brown (10YR 3/2) clay; weak structure; friable when moist, gradual boundary.

C1 5-10 in, dark brown (10YR 4/3) clay loam; weak, coarse structure; friable when moist, clear boundary.

C2 10-16 in, dark brown (7.5YR 3/2) clay loam; many very brown (10YR 3/2) mottling; weak, coarse prismatic structure; friable when moist; gradual boundary.

C3 16-24 in, dark brown (7.5YR 3/2-10YR 4/3) sandy clay; coarse prismatic structure; friable when moist, clear boundary.

C4 24-54 in, alternating strata of sands, loam, clay, and gravel in thickness from 1 to 3 in; slight to strong effervescence HCl.

Profile No. 10

Soils reference: Kafue basin alluvium.

Classification: Ferruginous tropical soils (Fersiallitic) (Jd).

Location: Chibila Area, Central Province.

Topography: Near level, ½% slope.

Parent material: Old alluvium from a mixed source.

Annual rainfall: 35 in.

Description:

Ap 0-5 in, very dark greyish brown (10YR 3/2) sandy loam; weak, fine, subangular blocky structure; slightly hard when dry, very friable when moist.

A3 5-11 in, dark brown (10YR 4/3-3/2) sandy clay loam; weak, fine, subangular blocky structure; hard when dry, friable when moist.

B1 11-17 in, brown (10YR 4/3) sandy clay; weak, fine, subangular blocky structure; hard when dry, friable when moist; few yellowish brown mottlings.

B21 17-27 in, brown (10YR 4/3) clay; weak, very coarse prismatic breaking to weak, fine, subangular blocky structure; hard when dry, very friable when moist; many medium strong brown mottlings.

B22 27-40 in, yellowish brown (10YR 5/4) clay; weak, coarse, prismatic breaking to weak, coarse subangular blocky structure; hard when dry; friable when moist; many strong brown and common, red mottlings.

B3 40-60 in, yellowish brown (10YR 5/4) clay; weak, coarse, prismatic structure; slightly hard when dry, very friable when moist; many brownish yellow and red mottlings, few fine, rounded hard laterite and manganese concretions.

6. Floodplain and Swamp Soils--This group includes soils developed on the upper Zambezi, Chambeshi, and Luangwa floodplains and in the Bangweulu, Lukanga, and other major swamps. Apart from the fact that they are seasonally flooded or waterlogged and are developed in alluvium, the soils in these floodplain and swamp areas have little in common, and they are described in separate subgroups below.

6a. Zambezi Alluvial Soils--These soils occur extensively north of Senanga in the western province. Smaller areas east of Sesheke, shown on the soil map of the western province, are described with the Valley soils in subgroups 8b and 8c.

North of Senanga the Zambezi floodplain soils are mainly pale-colored sands with a strongly acid, humic topsoil. About 10%-20% of the floodplain is estimated to have more loamy or clayey soils. These have a strongly acid, humic and usually loamy topsoil over a more clayey subsoil which is dark grey or grey and mottled yellow or brown to varying degrees. There are small areas of peat soils in permanently wet sites. The clay soils have lime and slickensides in the subsoil, like the black clays of group 4, but they have a strongly acid, loamy topsoil. This topsoil has resulted from a process of clay destruction (called "ferrolysis") which takes place in seasonally flooded soils that are flooded with clear water (without alluvium). This is the case on the upper Zambezi floodplain where most of the floodwater is derived by seepage from the Barotse sands and not from surface runoff.

The floodplain is flooded 1-3 m deep by the end of the rainy season. The level varies considerably from year to year, however. The flood begins to recede about May and most of the floodplain is above water by July-August. Most

of the soils remain moist in the subsoil through the dry season and the groundwater remains at a shallow depth.

Most of this floodplain is covered with grassland of various types. This is used for grazing by large herds of cattle in the dry season. Cultivation is restricted to a seepage zone (Sishanjo) bordering the floodplain and to old settlement mounds (Lizulu) on the floodplain.

Sishanjo soils range from humic sands, loams, and clays to peat in different sites. Some are used for rice. The majority are used for early maize and dry-season vegetables using ditches and raised beds to provide drainage. Weed control is a problem on these moist soils and burning of the topsoil eventually destroys the peaty layer. Crops could be improved by use of fertilizers, expecially nitrogen and phosphorus.

Lizulu soils are usually more clayey and less humic than surrounding sandy floodplain soils and some at least are lime rich. They are used for subsistence crops of maize, sorghum, etc.

The clayey floodplain soils would be very suitable for rice, especially for transplanted rice grown with irrigation after the end of the cold weather in the dry season. Because of the frequency of channels and canals on the floodplain, irrigation could be by simple, small-scale methods. Irrigation from shallow wells might also be possible. Cultivation of long-stemmed rice varieties (so-called "floating" rice) is also possible in the flood season but yields are likely to be lower and more uncertain than with transplanted rice varieties. Unfortunately (from the point of view of rice cultivation), these clay soils also provide the best grazing land. This is likely to lead to a clash of interests between traditional cattle owners and cultivators.

6b. Luangwa Alluvial Soils--The Luangwa Valley soils are mainly heavy black clays similar to those described in group 4 but they include more loamy and sandy soils occurring on slightly higher ridges (old river banks). There are also areas of slightly higher land which have mainly sandy soils developed over karroo rocks.

The most fertile soils are the loamy ridge soils. They are developed in old sandy alluvium which has become partly weathered, releasing clay and iron. They lie above normal flood level. These soils are almost black to a depth of 20-50 cm or more, gradually becoming dark brown or somewhat reddish brown below. They are sandy loam to sand clay loam in texture.

These are among the best soils in Zambia. They are easy to cultivate, well drained but with good moisture holding capacity, and have a large capacity to hold plant nutrients. They are mainly used for subsistence crops of sorghum and maize but are also well suited for cotton, groundnuts, sunflower, burley tobacco, and other crops requiring good soil drainage.

Lower down the floodplain ridges, the soils become dark brown and more compact in the subsoil. Chemically they are as rich as the more loamy ridge soils but cultivation is made more difficult by the heavier consistence. Most of these soils remain under woodland. The soils could be cultivated by machinery to produce good crops of maize, etc., under good management. However, their heavier consistence may make them less suitable for groundnuts and cotton.

Extensive almost level areas are occupied by black mopane clays and dambo soils. The latter have not been examined. The mopane clays are almost black, crack widely when dry, and are very sticky and plastic when wet. Most are probably badly affected by sodium in the subsoil. Some have a more sandy topsoil but most are clay from the ground surface. Many of these soils have been badly trampled by elephants and hippopotamus, which has caused local erosion of the topsoil.

These mopane clays would be difficult to bring under cultivation. Heavy equipment would be required, except where topsoils are loamy. Rice would be the most suitable crop to grow. Irrigation might be needed both in the rainy season and dry season in the dry valley climate, except in some dambos which remain wet throughout the year. Small amounts of rice are grown on some dambo margins at present.

6c. Chambeshi Alluvial Soils--These soils have been little studied to date. The most extensive soils appear to be developed in terrace alluvium, no longer flooded by the river, but lying waterlogged during the rainy season because of the level relief and an impervious substratum.

The terrace soils examined to date have had a dark grey sandy topsoil overlying a grey sandy subsoil which becomes more loamy or clayey and mottled red with depth. The soils are believed to be medium to strongly acid. They occur under grassland which is grazed by cattle in the dry season. Grazing could probably be improved under good management but the sandy texture and poor drainage provide these soils with a low potential for cultivation, even for rice.

Adjoining the Chambeshi River, there is a narrow strip of seasonally flooded young alluvial soils on rather irregular relief. The soils range from sands to clays in texture. These soils, especially the depression clays, provide good grazing land in the dry season. Rice is grown in the rainy season in some areas and could be grown more widely with irrigation in the dry season but cultivation of this crop provides a clash of interest between cultivators and cattle owners.

6d. Swamp Soils--These soils have only been examined around Lake Bangweulu but similar conditions probably occur in the Lukanga and other swamp areas shown on the Soil Map of Zambia.

The deeper swamp areas probably include large areas of peat soils similar to those described in subgroup 7b. The swamp margins have soils developed in alluvium washed in from surrounding upland areas. This is probably mainly clay but more loamy or sandy soils occur on slightly higher old river banks.

These soils all have a dark colored peaty topsoil ranging from a few centimeters thick on sandy ridges to 30 cm or more in depressions. The underlying layer is usually grey and mottled yellow, brown, or red to varying degrees in different soils. Almost all samples of these soils tested have been strongly or very strongly acid in reaction.

These soils occur under swamp grassland of various types which is grazed by game animals, especially lechwe. Rice cultivation would be possible but the irregular level of flooding from year to year would provide a problem unless the crop was grown with irrigation in the dry season.

Sandy ridges in and adjoining Lake Bangweulu and at the western end of the Lukanga swamp probably have podzols as described in subgroup 3e. A soil section seen near Samiya rest house had a well-developed podzol profile, with a dark-colored topsoil over a white subsoil and then a thick reddish brown layer of humus (or iron humus) staining and cementation at 1-2 m. Soil samples from some of the islands are known to be extremely acid and it seems probable that most of these sandy soils are podzols. These soils are extremely infertile but they are used for cassava cultivation around settlements (where the soils may be enriched by household refuse, including fish remains as well as animal and human excreta).

Profile No. 23

Soils reference: Seasonally waterlogged soils.

Classification: Hydromorphic soils (Na).

Location: Near Kembe, Central Province.

Topography: Nearly level, slope less than 1%.

Parent material: Limestone.

Annual rainfall: 35 in.

Description:

A1 0-8 in, very dark greyish brown (10YR 3/2) fine sandy clay loam; weak, subangular blocky structure; slightly hard when dry; common, reddish brown staining on root channels.

B21 8-15 in, dark greyish brown (10YR 4/2) fine sandy clay; moderate medium, subangular blocky structure; hard when dry; faint, diffuse, reddish brown mottling.

B22 15-25 in, dark yellowish brown (10YR 4/4) fine sandy clay; moderate, medium, subangular blocky structure; firm when moist; prominent, fine, reddish brown mottling.

B23 25-60 in, olive brown (2.5YR 4/4) fine sandy clay; weak, angular blocky structure; firm when moist; prominent, yellowish red mottlings; many soft, reddish brown concretions.

Profile No. 24

Soils reference: Seasonally waterlogged soils.

Classification: Hydromorphic soils (Na).

Location: Near Lukanga Swamp, Central Province.

Topography: Nearly level, slope less than ½%. Flooded for several months in most years.

Parent material: Alluvium from a mixed source.

Annual rainfall: 35 in.

Description:

A1 0-1 in, very dark grey (10YR 3/1) medium to coarse sand; structureless, loose when moist; clear boundary.

A2 1-15 in, grey (10YR 5/1) medium to coarse loamy sand; structureless; loose when moist; abrupt boundary.

B2tg 15-48 in, grey (N5/) fine to medium grained sandy clay loam; weak, very coarse, columnar structure; firm when moist.

B3gca. 48-100 in, light grey (N6/) sandy clay; massive; firm when moist, many fine, light olive brown mottles; few medium, calcium carbonate concretions.

7. Dambo Soils--Dambos are seasonally or permanently wet grassy valleys, depressions, or seepage zones on slopes. Thier soils are hydromorphic (with properties due to wetness) like the soils of subgroup 3f.

Dambo soils are of many kinds of different parts of the country. Black clay dambo soils are discussed in group 4. Solonetzic dambo soils, which occur locally on the plateau in the southern province, are similar in properties to the grey solonetzic soils described in subgroup 8c but in addition they are very susceptible to erosion. Other dambo soils are described below within two broad subgroups: (a) grey dambo soils and (b) dambo peats.

7a. Grey Dambo Soils--This subgroup includes a wide variety of soils ranging from sand to clay in texture. In the northern half of the country, and in permanently wet dambo centers in the south, the topsoil is often peaty for some centimeters on top (where it is more than 30 cm thick, the soils are regarded as peats, described in subgroup 7b). Elsewhere it is dark grey in color. Below this the subsoil is some color of grey ranging from almost white in some sands to dark grey in some clays. It is usually mottled with yellow, brown, or red. Some sands on valley-side seepage zones have laterite concretions or sheet laterite in the subsoil. Mottling decreases with depth and the soils become uniform grey in the permanently saturated zone (where this is reached before rock).

Most dambo soils of this kind are believed to be strongly or very strongly acid in reaction. A few gray, loamy, dambo soils examined in the south of the western province are neutral to alkaline in reaction and some have soft lime and silica spots within 1-2 m. These soils are of higher fertility. Where they are not too wet, they are used for maize cultivation. However, here as elsewhere in the country most dambo soils are used, if at all, only for dry-season cattle grazing. Very locally in the north small patches of rice are grown.

Over most of the country rice would be the most suitable crop to grow if cultivation of dambos was desired. Since in most valleys the dambo actually occupies a seepage zone on the lower slopes of the valley rather than an alluvial valley bottom, conditions would generally be more suitable for dryland rice

(hill rice) varieties than for transplanted rice. Most dambos do not retain enough water for dry-season irrigation but many are suitable for construction of small dams below which small areas of rice or other crops could be irrigated.

In dambos on the plateau in the south wheat is a possible crop to grow where the soils become dry enough for cultivation by May and irrigation can be provided. Maize could also be grown more widely, with or without irrigation, in the more fertile dambos in the southwest if outlets could be excavated to improve drainage.

With the exception of the latter soils, the natural fertility of dambo soils must be regarded as low. Heavy use of fertilizers may be necessary for good yields to be obtained of rice or other crops and liming may be needed to correct acidity in the wetter northern dambos. Loss of nitrogen by leaching through the generally sandy or porous seepage zone soils may be excessive. Puddling of the topsoil to reduce this loss would be an advantage where there is enough silt or clay to make this possible.

7b. Dambo Peats--These soils occur extensively in dambos in the podzol area east of Mongu. They probably occur in the center of many dambos in the northern half of the country too and in the deeper, wetter, areas of the Bangweulu, Lukanga, and other swamps. In the western province they generally occur under sour dambo types of grassland. In the north of Zambia it is possible that they also occur under reeds and papyrus.

Most so-called "peats" that have been examined are, in fact, mucks. The difference between peat and muck lies in the difference in degree of decomposition of organic materials. In peat decomposition is only partial and the leaves and roots of plants can easily be recognized. In muck decomposition is almost complete and remnants of plants cannot be recognized. Intermediate stages of decomposition are recognized as mucky peat and peaty muck according to the relative proportions of peat and muck present.

By definition peaty and mucky soils have more than 30 cm of organic material at the surface. Those examined in the Mongu area usually have 1-3 m of organic material. This is predominantly mucky but includes some layers of more peaty material. The soils are black near the surface becoming browner below, especially in peaty layers. They overlie white sand at depth.

The good reputation of peat soils belongs to soils occurring in areas of lime-rich groundwater. This does not apply to the dambo peats of Zambia, which are of a very strongly acid type. Such acid peats are typically deficient

in nitrogen, phosphorus, and several minor elements (such as copper). Once the surface root mat is disturbed, these mucky soils are too soft to support machines, animals, or man. If they are artifically drained, the muck shrinks and may dry so hard that it cannot be rewetted.

Nonetheless, dambo peats are cultivated in parts of the western province. A central drain is excavated down the valley center to lower the water table and small ditches are dug between fields to increase drainage. The topsoil is burned to destroy weeds and help the topsoil to become dry enough for cultivation. Burning also concentrates the sparse nutrients the peat contains. Maize and groundnuts are the main crops grown. Weeds provide a constant problem and fields may have to be left fallow periodically on this account. Drainage and burning gradually reduce the thickness of the peat. After 20-50 years--depending on the original thickness of the peat, the size fo the central drain, and the frequency of cultivation--a soil that was originally 1-3 m thick may be exhausted altogether leaving the underlying sterile sand exposed. This has already happened in some dambos near Mongu.

Techniques for permanent cultivation of peat soils are known but they would be difficult to apply under Zambian climatic conditions and in the sandy areas of the western province. These techniques involve rigid control of the water table at the same level throughout the year so that the topsoil always remains moist. The rate of shrinkage and wastage is then reduced although not prevented.

Profile No. 25

Soils reference: Floodplain soils.

Classification: Hydromorphic (Nb).

Location: Dambo on Chishinga Ranch, Luapula Province.

Topography: Nearly level, slope 0%-1%.

Parent material: Alluvium.

Annual rainfall: 50 in.

Description:

O1	2-0 in, dense mat of grass roots, some partially decomposed; spongy, black peaty material.
A1	0-17 in, black fine humified peaty material. Detectable sand fraction but very little clay.
ACg	17-30 in, black in the upper part to very dark grey (10YR 3/1) in the lower; sandy loam; very friable when moist.

C1g 30-46 in, light grey (5YR 6/1) sandy clay loam; massive; friable to firm when moist.

C2g 46-58 in, white (N8/_) sandy clay; massive; firm when moist.

Suitable crops to grow under such controlled conditions would be high-value vegetables and pineapples. Heavy use of fertilizers would be needed probably including several minor elements. Liming would also be necessary, except perhaps for pineapples. The problem of weed control may need to be overcome by use of herbicides although some of the worst weeds of these soils are sedges which are not easily controlled by this means.

8. Valley Soils--Soils in the Gwembe Valley are mainly developed over Karroo rocks and in colluvial sediments washed from them. The Karroo rocks range from sandstone and shales to basalt and give rise to a wide variety of soils. These are grouped together for convenience and described in three subgroups: (a) brown valley soils which are well drained and little leached, (b) brown podzolic soils which are well drained and mainly strongly leached, and (c) solonetzic (hardpan) soils which have impeded drainage.

8a. Brown Valley Soils--Typical brown valley soils developed over Karroo rocks, or in colluvium washed from escarpments of Karroo rocks, have a uniform brown or reddish brown appearance. The topsoil is usually slightly darker in appearance and slightly more sandy in texture than the subsoil, but the contrast is less pronounced than in the adjoining plateau area. Subsoil textures vary from sand to clay according to the parent rock. Most appear to be in the range sandy loam to sandy clay loam. Some soils over basalt are clays with basalt boulders occurring at a variable depth in the profile.

These are potentially very fertile soils, except where very sandy or stony. Most are slightly acid to neutral in the topsoil and neutral to slightly alkaline in the subsoil with lime appearing at some depth in the profile. A few are more acid in the upper subsoil, but they become neutral to alkaline in deeper layers. The soils have good reserves of calcium, magnesium, etc., and their clay is of a type which holds nutrients well.

The main problem of these soils is the hot and dry climate in which they occur. Even soils with good moisture-holding capacity suffer from drought in years of low rainfall. Sorghum is the main crop grown and cattle grazing is widely practiced. With irrigation the soils could be made highly productive under good management. Suitable crops for irrigation on the better sandy loam

and sandy clay loam soils are cotton, sugarcane, bananas, citrus, groundnuts, and fodder crops.

Profile No. 5

Soils reference: Valley soils.

Classification: Vertisol (Dj).

Location: Lunda Plains, Luangwa Valley, Northern Province.

Topography: Gently sloping.

Parent material: Calcareous mudstone.

Annual rainfall: 30 in.

Description:

A1 0-14 in, very dark brown (7.5YR 2/2) clay; strong, coarse prismatic breaking to anuglar blocky structure; very hard when dry; glossy surfaces on peds; numerous grass roots.

Cca 14-26 in, dark brown (7.5YR 3/2) clay; moderate, coarse, angular blocky structure; very firm when moist; glossy surfaces on peds; many slickensides; common, small calcium carbonate concretions.

C1 26-37 in, dark brown (7.5YR 4/2) clay loam; weak, medium angular blocky structure; firm when moist; glossy surfaces on peds; few slickensides; many blocky fragments of weathered mudstone.

C2 37-60 in, reddish brown mudstone; breaks into small angular blocks; hard when dry; very few roots confined to cracks between the blocks.

8b. Brown Podzolic Soils--Brown sands occurring east of Sesheke are much poorer soils than those described above. They are developed in colluvial and terrace materials at the foot of the Barotse sands plateau. The most extensive soils are podzolic. They have a dark greyish brown topsoil containing some white sand grains--but less than in the podzolic soils described in subgroup 3d--overlying a thick dark brown to somewhat reddish brown subsoil. This has several thin wavy bands (called "lamellae") in the deeper layers. Soils transitional to solonetzic soils of subgroup 8c have a layer of white sand at between 1 and 2 m overlying a hardpan.

These sands are mainly medium to strongly acid in the topsoil and more strongly acid below. A few are nearly neutral in reaction throughout. Soils with a hardpan are strongly acid in the subsoil and white sand layers but are

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slightly to strongly alkaline and lime rich in and below the hardpan. The clay is of a type which holds nutrients well so that despite the low content of clay the soils are somewhat better provided with nutrients than adjoining Barotse sands soils.

They are nonetheless poor agricultural soils because of the low and uncertain rainfall they receive. They are used for bulrush millet, sorghum, Livingstone potatoes, and cattle grazing around settlements but large areas remain under natural woodland. Irrigation of these rapidly permeable sands would be expensive and best used for vegetables and fruit trees tolerant of the frost which occurs in most years in the Sesheke area.

Profile No. 6

Soils reference: Valley soils.

Classification: Ferruginous tropical soils (Fersiallitic) (Ja).

Location: Luangwa Valley South Game Reserve, Eastern Province.

Topography: Nearly level.

Parent material: Sandstone.

Annual rainfall: 30 in.

Description:

A1	0-8 in, very dark greyish brown (10YR 3/2) sand; single grained to weak, subangular blocky structure; soft when dry.
C1	8-24 in, yellowish brown (10YR 5/6) sand; single grain; slightly hard when dry; weak, patchy, dark staining.
C2	24-56 in, strong brown (7.5YR 5/6) sandy loam; single grain; hard when dry.

8c. Solonetzic Soils--These soils are developed extensively in level basin areas and "pans" among both the brown valley soils and brown podzolic soils. They range from dark-colored clays under mopane woodland to grey sandy or loamy hardpan soils under grassland.

The dark-colored mopane soils are similar to black clay mopane soils described in group 4 and subgroup ob. In the Gwembe Valley these soils tend to be browner in color. They have high sodium contents and some are saline in their lower layers. They are poor agricultural soils but could be developed for transplanted rice cultivation with irrigation.

Reclamation for cultivation of other irrigated crops, such as maize and cotton, would require provision of a major drainage system and might take many years to achieve. After provision of drainage cultivation of irrigated rice for several years would be the best way of washing out excess sodium and salts from the soils before introducing the cultivation of dryland crops.

The grey solonetzic soils have a distinctive profile. They are sandy for a few centimeters at the surface (and up to a meter in some soils transitional to brown podzolic soils of subgroup Sh). Below this is a layer of white sand, only about a centimeter thick in normal soils, but up to 20 cm thick in soils transitional to podzolic soils. This white sand forms a crust on top of a hardpan layer. This hardpan ranges from grey to dark grey in color and from sand to clay in texture in different soils. As the name suggests, it is very compact, both when wet and dry, sufficient to prevent water and roots passing through. The soil below contains soft lime, sometimes in large amounts, mixed with a white silica deposit.

The topsoil and the upper few centimeters of the subsoil are slightly to strongly acid in reaction. The lower part of the profile is alkaline, sometimes strongly so. In addition to lime and silica this layer contains enough sodium to make it compact and it is often saline, in addition.

These are very poor agricultural soils. Water accumulates above the hardpan during the rainy season causing waterlogging. The hardpan is difficult to break up for cultivation and would tend to return unless the excess of sodium causing it could be reduced by drainage or irrigation. As with the mopane clays, irrigation of transplanted rice would be the best method of using and reclaiming the soils.

9. Rock and Rubble--This unit includes the main areas of rocky hills and escarpments. Many different kinds of rock occur within the areas shown on the Soil Map of Zambia and various colors and textures of soils occur. The main soils occur on steep slopes. On hard rocks there are many outcrops. Over softer rocks the soils can be quite deep and are usually of a red color.

These steep soils are of limited use for agriculture. From the agricultural point of view the most important point is to keep them under protected forest reserves so as to minimize erosion and runoff which might cause floods in lower land of better agricultural value. Such protection can increase the adsorption of rainfall and allow the water to seep out more slowly so as to maintain river flow in the dry season.

The unit shown on the Soil Map of Zambia is highly generalized. Reconnaissance surveys, using airphoto interpretation, will almost certainly reveal some areas of soils suitable for agriculture. In such hilly areas good soils often occur as a broad or narrow band at the foot of steep hills where material from the slopes above has washed down and accumulated. Such hill-foot zones are called fetile soils, but piedmont soils usually also benefit from moisture seeping out of the hills. Under good management, including soil conservation measures, they can be very productive soils.

Profile No. 1

Soils reference: Rock and rubble.

Classification: Lithosol (Bc).

Location: Near Mukalaikwa, Central Province.

Topography: Nearly level upland plain.

Parent material: Sandstone or quartzite.

Annual rainfall: 33 in.

Description:

A1 0-14 in, dark brown (7.5YR 3/2) loamy sand; weak fine granular to single grain; loose when dry and moist; clear boundary.

C 4-10 in, reddish brown to yellowish red (5YR 4/4-4/6) loamy sand, weak fine granular to single grain; soft when dry, loose when moist, nonsticky when wet; contains few to many subrounded hard laterite gravels up to 10 mm in diameter and few quartz gravels (amount of gravels increase with depth).
Abrupt, wavy boundary.

Cm 10-15+ in, massive laterite crust with black, red, yellow, and brown colors. Sand common in the pores with a few subangular quartz stones up to 80 mm in diameter.

Profile No. 2

Soils reference: Rock and rubble.

Classification: Lithosol (Bd).

Location: Southeast of Choma, Southern Province.

Topography: Hilly Zambezi escarpment.

Parent material: Mica schist.

Annual rainfall: 32 in

Description:

A1 0-5 in, dark reddish grey to weak red (5YR-2.5YR 4/2) gravelly sandy loam, reddish brown (5YR 5/3) when dry; moderate, fine granular structure; soft to slightly hard when dry, pH 6.1; clear boundary. Gravel consists of many pieces of weathered mica schist and its saprolite.

C1 5-15 in, red(2.5YR 4/6) gravelly, stony, sandy clay loam; weak, fine granular structure; pH 6.7; diffuse boundary. Horizon consits of over 75% weathered mica schist and its saprolite.

C2 15-42 in, weathered mica schist and saprolite with red (2.5YR 4/6) films on weathered faces; diffuse boundary.

C3 42-60 in, weathered mica schist with reddish brown (2.5YR 4/4) films on weathered faces; pH 6.9.

Remarks: Surface stones and outcrops are common in the surrounding area.

Table Analysis of Representative Zambian Soil Profiles

	Depth inches	Coarse sand 2.0-0.2	Fine sand 0.2-0.02	Silt 0.02-0.002	Clay <0.002	Org C %	Total N %	Ca	Mg	K	Na	Cation Exch Cap	[illegible]	[illegible]	CEC [illegible]	
Profile No. 3	0-5	2	22	25	46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	10-16	1	42	[illegible]	[illegible]	0.61	0.059	[illegible]	4.0	0.1	0.2	[illegible]	[illegible]	[illegible]	[illegible]	
	16-24	1	63	8	[illegible]	[illegible]	0.043	34.3	3.5	0.2	0.2	40.5	100	[illegible]	146	
Profile No. 4	0-3	1	27	[illegible]	[illegible]	2.05	0.128	36.2	22.1	1.6	3.4	61.5	97	[illegible]	—	
	12-16	1	16	[illegible]	67	0.91	0.046	30.5	14.2	1.4	1.6	61.5	100	[illegible]	95	
	42-48	2	14	16	68	0.31	0.016	22.3	19.7	0.5	2.8	62.1	100	[illegible]	92	
Profile No. 5	0-10	—	30	24	45	1.05	[illegible]	27.9	[illegible]	0.7	0.2	41.0	100	[illegible]	—	
	16-22	—	37	23	40	[illegible]	[illegible]	[illegible]	[illegible]	0.6	0.1	41.9	100	[illegible]	[illegible]	
	25-35	1	42	[illegible]	[illegible]	0.34	0.032	[illegible]	[illegible]	0.6	1.2	33.3	100	[illegible]	[illegible]	
Profile No. 6	0-8	33	57	5	5	1.20	0.050	[illegible]	[illegible]	0.1	0.1	4.4	81	[illegible]	[illegible]	
	12-18	30	60	4	5	0.30	0.019	0.4	[illegible]	0.1	—	[illegible]	52	[illegible]	[illegible]	
	44-56	26	31	[illegible]	11	0.20	0.020	1.3	1.3	0.2	0.1	3.6	76	[illegible]	[illegible]	
Profile No. 7	0-6	24	45	6	20	2.75	0.140	10.4	4.0	[illegible]	—	17.2	83	6.1	—	
	6-18	20	[illegible]	3	32	1.27	0.078	6.4	2.0	[illegible]	—	14.0	69	[illegible]	44	
	24-30	24	27	7	40	0.78	0.054	2.5	3.4	0.4	—	13.4	69	5.8	34	
Profile No. 8	0-6	19	64	6	11	1.12	0.072	[illegible]	[illegible]	0.4	—	[illegible]	93	[illegible]	—	
	6-16	15	46	5	34	0.72	0.060	2.4	2.5	0.5	—	10.3	52	4.5	33	
	16-32	10	42	6	42	0.59	0.054	3.0	3.5	0.5	—	11.2	52	4.8	28	
	32-62	11	40	5	44	0.36	0.042	3.0	3.5	0.6	—	12.3	57	5.0	28	
Profile No. 9	0-12	7	42	7	44	2.10	0.109	12.0	9.8	0.2	—	27.7	79	5.7	—	
	12-33	6	27	13	54	1.01	0.083	10.8	6.2	0.1	—	23.7	73	6.2	44	
	36-58	7	29	15	50	0.60	0.063	10.1	5.2	0.1	—	20.9	74	6.3	42	
Profile No. 10	0-5	19	35	10	16	0.81	0.065	6.0	2.0	0.2	—	10.5	79	4.41	—	
	5-11	16	43	10	31	0.96	0.056	9.0	3.2	0.1	—	13.5	[illegible]	4.2	46	
	11-17	14	35	12	39	0.87	[illegible]	10.0	2.4	0.1	—	14.4	[illegible]	4.4	37	
	17-27	13	29	12	46	0.62	0.046	9.8	3.0	0.2	—	[illegible]	[illegible]	4.8	34	
	27-40	11	29	10	50	0.41	0.019	10.4	3.6	0.2	—	[illegible]	[illegible]	5.1	31	
	45-70	11	31	13	45	0.33	0.011	11.2	3.7	[illegible]	—	15.2	[illegible]	5.7	34	
Profile No. 11	2-6	44	36	3	17	1.17	0.062	2.2	0.5	0.2	—	4.6	[illegible]	5.8	—	
	12-18	44	20	3	33	0.44	0.014	1.3	0.5	0.2	—	[illegible]	[illegible]	5.6	12	
	26-30	35	24	6	33	0.24	0.013	1.0	0.6	0.2	—	3.6	[illegible]	5.6	11	
Profile No. 12	0-3	24	64	5	7	[illegible]	0.060	2.3	1.0	0.2	—	4.2	[illegible]	6.5	—	
	3-7	25	63	2	10	[illegible]	0.013	0.4	0.1	0.2	—	[illegible]	[illegible]	5.3	30	
	17-30	24	57	3	16	0.24	0.027	0.7	0.5	0.2	—	[illegible]	[illegible]	5.9	23	
	30-48	19	48	3	30	0.24	0.021	0.3	0.9	[illegible]	—	[illegible]	[illegible]	5.6	15	
	48-72	18	52	3	27	0.130	0.022	1.2	0.8	0.1	—	[illegible]	[illegible]	5.9	12	
Profile No. 13	0-6	63	30	3	4	0.74	0.032	0.7	0.1	0.1	—	[illegible]	[illegible]	5.3	—	
	13-18	47	35	3	[illegible]	0.21	0.025	[illegible]	0.2	0.1	—	[illegible]	[illegible]	[illegible]	17	
	34-40	52	28	[illegible]	[illegible]	0.16	0.018	0.6	1.2	0.4	—	[illegible]	[illegible]	[illegible]	21	
Profile No. 14	3-6	80	9	—	1	0.10	0.013	Ca + Mg	0.2	0.1	—	[illegible]	7	4.6	—	
	28-30	63	30	—	2	0.04	0.005	Ca + Mg	0.1	0.1	—	[illegible]	19	4.7	31	
Profile No. 15	1-6	19	[illegible]	[illegible]	2	0.55	0.054	2.1	0.5	0.1	—	[illegible]	[illegible]	5.3	—	
	24-30	18	[illegible]	[illegible]	1	0.27	0.016	0.5	0.2	0.1	—	[illegible]	[illegible]	5.5	37	
	54-60	[illegible]	76	1	5	0.27	0.010	0.4	0.3	0.1	—	[illegible]	[illegible]	4.8	15	
Profile No. 16	0-6	37	47	2	19	1.25	0.072	[illegible]	0.2	0.2	[illegible]	[illegible]	16	4.1	—	
	18-24	25	34	2	39	0.37	0.035	[illegible]	0.2	[illegible]	[illegible]	[illegible]	10	4.0	15	
	48-52	24	35	4	37	0.10	0.022	0.3	0.0	0.1	[illegible]	[illegible]	12	4.0	11	
Profile No. 17	0-6	24	63	4	9	0.72	0.030	2.3	1.2	0.2	—	5.0	[illegible]	[illegible]	—	
	6-18	18	45	4	31	0.27	0.012	0.4	1.1	0.3	—	[illegible]	34	4.3	16	
	36-40	11	50	4	35	0.10	0.022	0.3	0.9	0.3	—	[illegible]	25	4.1	15	
Profile No. 18	0-7	18	43	15	24	—	—	0.4	0.3	[illegible]	—	[illegible]	[illegible]	4.2	—	
	[illegible]	11	43	[illegible]	23	—	—	0.1	0.1	[illegible]	—	[illegible]	[illegible]	[illegible]	30	
	[illegible]	11	31	10	[illegible]	—	—	0.1	0.2	[illegible]	—	[illegible]	[illegible]	4.1	13	
	[illegible]	4	24	15	57	—	—	0.1	[illegible]	[illegible]	—	[illegible]	[illegible]	4.3	11	
Profile No. 19	0-5	15	51	6	23	1.21	0.070	0.1	0.3	[illegible]	—	[illegible]	[illegible]	4.0	—	
	15-24	10	46	6	[illegible]	0.61	0.042	0.1	0.2	[illegible]	—	[illegible]	[illegible]	4.0	7	
	44-50	[illegible]	43	6	43	0.27	0.010	0.1	0.2	[illegible]	—	[illegible]	[illegible]	[illegible]	13	
Profile No. 20	0-6	[illegible]	56	[illegible]	[illegible]	1.34	0.102	1.0	0.5	[illegible]	—	[illegible]	37	5.3	—	
	12-18	[illegible]	55	[illegible]	[illegible]	0.28	0.022	[illegible]	[illegible]	[illegible]	—	[illegible]	37	4.5	12	
	40-46	[illegible]	59	[illegible]	24	0.20	0.011	0.1	0.1	[illegible]	—	[illegible]	[illegible]	4.5	11	
Profile No. 21	0-8	26	[illegible]	4	[illegible]	1.17	0.074	[illegible]	2.9	0.3	0.1	[illegible]	31	5.9	—	
	[illegible]	36	54	[illegible]	5	0.25	0.025	[illegible]	[illegible]	[illegible]	0.2	4.4	[illegible]	7.0	107	
	33-43	24	48	4	14	0.43	0.032	[illegible]	2.5	[illegible]	0.2	[illegible]	100	6.4	31	
Profile No. 22	0-4	24	42	12	22	2.54	0.195	[illegible]	5.7	3.9	0.3	[illegible]	100	7.1	—	
	4-12	9	25	[illegible]	64	0.59	0.048	[illegible]	10.3	[illegible]	[illegible]	[illegible]	[illegible]	8.0	[illegible]	
	[illegible]	8	24	26	42	0.47	0.033	[illegible]	10.2	0.3	9.0	[illegible]	[illegible]	8.0	[illegible]	
Profile No. 23	0-8	7	57	9	23	2.91	0.094	4.0	2.7	0.5	—	[illegible]	71	5.5	—	
	17-24	5	[illegible]	[illegible]	38	[illegible]	0.074	1.2	2.1	0.2	—	[illegible]	41	[illegible]	22	
	42-50	6	47	7	[illegible]	2.51	0.052	1.2	2.5	[illegible]	—	[illegible]	[illegible]	[illegible]	21	
Profile No. 24	4-12	59	[illegible]	7	4	—	—	[illegible]	0.4	[illegible]	[illegible]	[illegible]	81	[illegible]	—	[illegible]
	20-27	30	[illegible]	1	[illegible]	—	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	33	26	1	43	—	—	5.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Profile No. 25	[illegible]	—	—	—	—	[illegible]	[illegible]	[illegible]	2.5	0.2	—	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	—	—	—	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	42	37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

* [illegible]

Source: Brammer, H., Soils of Zambia, Rural Information Services, Ministry of Rural Development, 1976.

ANNEX C

TERMS OF REFERENCE

A study of the fertilizer subsector was conducted by the Planning Division of the Ministry of Agriculture and Water Development during July, 1988. Economists of the Planning Division were assisted by staff from the National Agricultural Marketing Board, the Department of Marketing and Cooperatives, and fertilizer specialists from the International Fertilizer Development Center, the United States Agency for International Development and Iowa State University to address the problems faced in the subsector. This study identified a number of existing constraints which result in excessive losses in the fertilizer marketing and supply system and undue cost to Zambia's economy. A number of alternatives were suggested for alleviating these constraints. The main recommendation of the report was that a more detailed evaluation of these and other alternatives be conducted for the development of a plan of action which would lead the design and implementation of an improved fertilizer marketing system. Such a study should take into account all the technical, economic, educational and policy implications of alternative strategies which might be followed. The suggested three-step approach for the development and implementation of the needed action plan includes terms of reference for:(1) the acquisition of the needed information base, (2) the preparation of an action plan involving appropriate short term technical assistance and (3) the use of appropriate technical personnel to assist in the establishment of the improved fertilizer marketing and supply system. The terms of reference follow:

TERMS OF REFERENCE FOR THE ACQUISITION OF THE INFORMATION BASE

I. Compile statistical data on:

A. Population by province and total for Zambia (1972-82 with projections to 1995).

1. urban
2. rural
3. annual growth rates of urban, rural and total
4. population growth rates per square Kilometre (1972, 1982, projected to 1995)

B. Educational level by province (1983)

1. agricultural
2. non-agricultural
3. number, type ;and capacity of schools teaching agricultural subjects
4. for those training institutions offering specialized agricultural training, cite the curriculum, the level of attainment, and the number of graduates per year
5. cite number and type of training received by those individuals outside of Zambia

C. Number of rural households by district and province and total for Zambia

1. totals by district, by province, by commercial, emergent and subsistance categories
2. totals by district, by province, by farm size
3. districts and provinces where rural households have access to newspapers, radio, TV, cinemas

D. Employment by district, province and total for Zambia (1983)

1. agricultural

   a. farmowners

   b. renters

   c. paid laborers

   d. unpaid family workers

2. non-agricultural

E. Earnings by Province and Zambia (1988)

1. total earnings

   a. agricultural

   b. non-agricultural

   c. by farmers from non-agricultural sources

2. cash sales by farm class (1988)

   a. commercial

   b. emergent

   c. subsistence

3. average income per capita (1978-1983)

   a. agricultural

   b. nonagricultural

4. average income per farm family by farm class (1978-1983)

5. farm production budgets by farm class (1988)

   a. cash expenditures by nature of expense

   b. cash income by source of income (crop,animal,milk,etc.)

   c. costs of production

F. Food balance (1978-1983)

1. exports

   a. agricultural products, by commodity and degree of processing

   b. non-agricultural

2. imports

a. agricultural commodities, amounts, value and period of receipt

b. agricultural capital items (farm level)

G. Transportation by province (1983)

1. railroads

a. location, length, guage of mail lines

b. location, length, and access of open and private

c. number, type, capacity and inside measurements of operable railcaps

d. number, type, size of power units, operable and repairable

e. nature and location of repair facilities

f. frequecy of rescheduled frieght service

g. organization and operation of total rail network

h. freight charges per ton/kilometre

2. roadways

a. location, length, capacity by type of surface

b. organizations, equipment and capacity of vehicles for road haulage of commodities

c. costs per ton/kilometre

3. ports - capacity, location, facilities, etc.

H. Geographical data

1. climate, i.e. rainfall, temperatures, etc.

2. soils

3. seasonality of weather

4. suitablility of areas for crop production

5. location of minerals useful in agricultural production
6. land suitability classes by area and location
7. water resources for agricultural production, location and amounts
8. land under irrigation, area, location, type of irrigation

I. Land tenure system

J. Land use by district, province and total for Zambia

1. total agricultural land (1973-1983)
   a. crop land
   b. improved pasture
   c. range land
   d. forest
   e. other
2. total non-agricultural land
3. crop area harvested, production and yields (1973-1983)
   a. estate or plantation crops, sugarcane, coffee tobacco, tea, other
   b. food crops (irrigated, rainfed)
4. cropping systems
   a. cash crop
   b. livestock and grain
   c. livestock
   d. dairy
   e. other
5. commodity prices and markets (1973-1983)
   a. farm-gate and delivered prices
   b. location of commodity markets and processors
   c. methods of payment by buyers

II. Determine shifts in crop areas or yield increases required to meet food and fiber production goals and estimate increased fertilizer nutrients requirements needed to meet these goals

III. To provide all historical data related to fertilizer consumption in Zambia by district from 1971-1988

IV. Identify the financial resources used by the Zambian fertilizer sector and to project future funding required

V. Identify by cultural region the three major factors which influence

commercial farmers, emergent farmers, and traditional farmers to use fertilizer

A. What causes each group to invest in fertilizers? (farm size, income, education, status)

B. Where do they get their information?

C. How many of each group use recommended fertilizer rates, methods

and time of application, complete nutrient application (including lime)?

D. Which groups are mostr difficult to reach?

VI. Identify what factors have limited the use of fertilizer in Zambia

a. unavailability of fertilizer or seed

b. farm or institutional credit

c. crop marketing facilities

d. high prices for fertilizer or other inputs

e. taxes

f. low crop prices

g. food imports

h. inadequate knowledge of farmer

i. improper fertilizer application

j. risk of crop failure

K. lack of irrigation

l. inadequate credit

m. land tenure and farm size

n. lack of crop or fertilizer storage

o. crop response to fertilizer

p. crop intensity

VII. Identify present and future demand centers and warehousing requirements.

VIII. Determine agronomic potential of fertilizer nutrients.

XI. Enumeiate the organizatonal framework and the degree of staff development of all Zambian institutions, public and private, concerned with the productin, marketing and use of fertilizer and show mechanisms of coordination between them.

A. Describe the responsibilites of the aplpropriate Ministries with respect to supply, production, pricing, distribution research, and educational programs.

B. Within each ministry, cite the responsibility location of capital assets sub-units, indicate the number of staff, their educational levels and disciplineof other academic training.

C. Describe the Zambian fertilizer research programs underway and those activities that relate to the current state of fertilizer knowledge. Specific attention should be directed to fertilizer and soil fertility research which will develop the many crop response curves to the application of needed nutrients on major soils on farmers fields.

D. Cite research data by province, that is used as a basis for

current fertilizer recommendations for all soils and crop systems.

E. Describe agencies, by district, means and methods used by which fertilizer knowledge is transmitted to farmers of each class.

F. Describe specific rural education programs which deal with soil and crop production.

G. Describe the formal and non-formal education in soil fertility and fertilizers presented at the various school levels.

X. Determine how fertilizer prices are set, whether margins are sufficient and examine the use of credit through the system.

XI. Identify current policies related to fertilizer use, and assist their impact.

A. Industrial

1. production subsidy
2. transportation subsidy
3. raw material subsidy
4. tax subsidy
5. import subsidy
6. labor subsidy
7. storage subsidy
8. credit subsidy
9. others (related to fertilizer)

B. Agricultural

1. farm subsidy
2. credit subsidy
3. indirect (extension, research, cooperatives, etc.)

C. Describe specific development programs and give a general appraisal as to their effectiveness in promoting fertilizer use. Describe each as to:

1. who administers
2. operating budget
3. what is offered to farmers
4. how it increases fertilizer use
5. how many hectares are affected in each province and in Zambia (1973-1983)
6. how much fertilizer was pruchased and properly applied as a result of the program (1973-1983)
7. how much food production has been increased as a result of the program (1973-1983)

D. Describe current government policies regarding the following issues and state their advantages, disadvantages and effects of each policy.

1. government versus private ownership of fertilizer production and marketing facilities
2. Fertilizer in Zambia is currently "distributed" rather than marketed. Should more emphasis be placed on marketing in the future?
3. Many organizations are involved in the fertilizer sector. Should a united system be established?
4. Should fertilizer prices be directly subsidized? Indirectly?
5. What policies, if implemented, would reduce the cost of fertilizer to the farmer?
6. Describe the relevant governmental policies and action programs [illegible]

transport, storage and delivery to the farm.

XII. Describe existing systemsused for receipt of raw ma rials, the distribution of finished products and forecastof future requirements.

A. Discuss courcrs of information and methods used in sales forecasting for each market segment and describe how these are used in planning distribution.

B. Describe in-bound modes of transport, receiving facilities, handling procedures, and system used for monitoring management (organizational structure, planning, coordination, execution and control.

C. Describe the seasonality of consumption for 1973 and 1968, by product, by month, by division.

D. Describe the order processing system

E. By means of charts, show routes of movement by origin to farm, by product, by month, by division.

F. By means of tables, show location of yearly sales by rural depot or similar retail outlet.

G. Determine average distance a farmer must travel to purchase fertilizer in each province.

H. Describe how fertilizers aremoved fromruraldepots to farms. What is the average size of purchase in each market segment? Does he buy more than one type of product at the time of purchase? Does he apply or store his purchased product ?

I. Describe the flow or changes in title of the fertilizer products as they move from manufacturer to farmer.

J. Summarize the physical flow, the information flow, the title flow and the financial and monetary flow without the

distribution system.

K. Describe constraints, sourceof losses, scheduling problems, effects on product quality in current system.

L. Describe existing packing by specification and survival within the system.

FERTILIZER SUPPLY

XIII. Identify the supply sources of various fertilizers and products and the future supply needs by product.

A. identify existing fertilizer and lime production facilities

1. location, date, materials used as feed stock and source of feed stock

2. production levels for 1974-84 compared with nameplate capacity and production by product by month for 1981-1984

3. identify any factors which will increase production and product quality.

4. estimate production costs

5. describe planned facilities (for lime production) with an evaluation of probability of project completion and date this plant will achieve production capability.

B. Identify out-of-country (off-shore) supply system

1. Describe procurement procedures

a. forecasting amounts, money, tendering seasonality of shipment, title

b. organizations involved

c. timing of receipts

2. supply facilities

a. ports-berths, off-loading capacity, bulk-handling facilities, forwarding agents, storage, rail and

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truck loading facilities

b. transit modes and facilities

c. product packaging and shipping facilities, etc.

d. storage size, location, structures, handling procedures

e. product title passages

f. management system

SUPPLY/DEMAND

XIV. To determine the demand for various fertilizer products in Zambia from 1984-1994.

A. Summarize domestic supply projections for Zambia (total) by province and by district for 1973-1983.

1. by product

2. by nutrient

B. Summarize consumption projections for Zambia (total) and by province and by district and project balances for 1984-87, 1990 and 1994.

1. by product

2. by nutrient

C. Estimate needs for Zambia (total) and by province, by district for 1984-87, 1990, 1994.

1. by product

2. by nutrient

XV. Provide information on quantity and quality of indigenous deposits major fertilizer raw materials with assessment of mineable or recoverable reserves and the efficiency of fertilizer and lime production utilizing these materials.

A. i. Nitrogenous fertilizer raw materials

a. refinery waste

b. coal

2. phosphate rock

3. sulfur

4. limestone

5. potash salts or brines

6. mine waste

7. other

B. Indicate which deposits have been developed and quantities recovered in 1981, 1982, and 1983.

C. Indicate those deposits which have high potential for development

D. Project requirements for raw materials used in existing production facilities, showing local and import requirements.

TERMS OF REFERENCE FOR FERTILIZER SUPPLY AND MARKETING PLAN IN ZAMBIA

Based upon an anlysis of the data concerning the existing fertilizer system and the supply/demand forecast a plan to make fertilizers available to farmers that most efficiently meet their needs at the least social cost to Zambia will be prepared. Such a plan will enunciate a marketing and supply system tailored to the economic, social, cultural, political, legal and financial environment of Zambia.

I Describe the concepts and methodology to establish the capital, managerial Skills and organization to service the fertilizer sector.

(a) Farmer's needs
(b) Retailer selection
(c) Marketing services of research education development
(d) Sales administration
(e) Distribution management
(f) Supply and procurement
(g) Organizational policies

II Describe the required organizational structures needed initially, for 1987 and 1994.

(a) Phasing of marketing and supply operations
(b) Marketing communications - forms, records and reports
(c) Job descriptions and limits of authority
(d) Budgets

III Product Plan

(a) Products to meet agronomic requirements
(b) Domestic production

1. Nitrogen products
2. Phosphate Study
3. Lime Study

(c) Off-shore procurement

1. Raw materials

2. Finished products

(d) Bulk-Blending Study

(e) New products

(f) Facility requirements

(g) Supply alternatives

(h) Packaging

IV Sales Plan

(a) Sales objectives by product, by rural depot (retailer), by month.

(b) Projection if sales for next 5 years by product, by district.

(c) Considerations of product quality and type, packaging requirements, pricing, movement constraints and organization and government policies are considered, planning and execution of all agronomic research and service activities. He provides every pictures and other materials to the advertizing educational and promotionel materials.

(d) A soils testing and fertilizer recommendation system will be studied

(e) For assignment of field and regional agronomists, etc.

(f) Transport and equipment requirements

(g) Budget

VI Advertising and Sales Promotional Plan

(a) The purpose of this plan is to identify areas where efficient communications systems can be used to support the operations of the marketing organizations.

(b) After an analysis of the information base, opportunity areas for the production of training materials, the use of newspapers, radio, cinema, signs, porters, specialities will be established.

(c) A detailed action schedule for use of media etc will be prepared for the first year.

(d) A system for the evaluation of

(d) Identity opportunities to sales

(e) Establish sales strategy

(f) Specify a detailed action schedule with fixed responsibility and target data for completion for the first year establishment of the sales organization. Such items that are included are retailer survey, sales forecasting system, retailer (depot) manager contracts, other organizational contracts, training dates, sales terms and policies forms, records and reports required.

(g) Receives approves and transmits orders to distribution manager.

(g) Assignment of sales territories, regional or provincial managers, etc.

(h) Coordinates with marketing services and distribution

(h) Transport requirements

(i) Budget

V Agronomic Plan

(a) Demonstrations, field days, farmer meetings, farm visits, retailer development and limited field research will be the educational activities conducted by field agronomists.

(b) For first year or organization, a detailed action schedule citing the postings, assignment of functions, provincial supervision will be made for each agronomic activity.

(c) A chief agronomist will be responsible for these actions will be establishe

(d) An in-house organization will prepare camera - copy for reproduction and teaching materials for use by field agronomists.

(e) Budget.

VII Market Research Plan

(a) Identifies available data

(b) Collects needed field data in cooperation with field agronomists, sales personnel and warehouse supervisors.

(c) Studies documents from Central Statistics office, agricultural development projects, national plans, research reports, etc.

(d) Maintain files needed to prepare annual marketing plan and required to appraise performance.

(e) Consolidates monthly sales forecasts

(f) Maintain data files for supply, marketing, financial, product line and other plans.

(g) Evaluate the economics of fertilizer use at farmer level

(h) Conducts studies as a basis for subsidies and price support programs.

(i) Establish an annual action schedule for first two years of organizational operations.

I Distribution Plan

(a) Establishes a physical distribution system for transportation, warehousing, inventory control, documentation and management of the system.

(b) Rail transport plan

1. Freight Rates
2. Structure of proposed system
3. Wagons required, design, and maintenance
4. Distribution zones
5. Manual v.. mechanical handling
6. Packages and Pallets for rail movement
7. Operation of rail shipment

(c) Handling methods study

(d) Warehousing

1. Facilities: i) Location, size, design.
2. Storage methods
3. Inventory control
4. Handling methods
5. Shipping system
6. Management and operations: i) Documentation procedures & reports.

(e) Primary and secondary distribution costs companions
(f) Special plan for port facilities.
(g) Bulk storage sites, if any.
(h) Blending vs. compounding requirements, if any.
(i) Recommended government policy.
(j) Budget summary and forecast
    1. Capital
    2. Operational

IX Price Plan

(a) Costs of Products
(b) Marketing margins
(c) Supply and distribution costs
(d) Price by product at Farm Gate
(e) Analysis of present and projected price policies
(f) Role of direct and indirect fertilizer subsidies

X Personnel Development Plan

(a) Organizational employment policies
(b) Subjects to be taught as a basic marketing training for all personnel employed in marketing division, will be planned.
(c) A professional selling course for all sales personnel will be planned.
(d) A practice of supervision course for all management personnel will be planned.
(e) A general management course will be planned for all provisional middle, and senior managers.
(f) Instructional material for instruction fertilizers will be provided for use in retailer and farmer educational endeavors.
(g) Plans for retailer development will be provided.
(h) Plans for farmer educational meetings will be provided.
(i) Selected organizational personnel will be provided formal educational opportunities outside of Zambia.

XI Fertilizer - Related Policies

(a) In addition to those policies cited in previous sections, the GRZ will need to formulate and implement several new fertilizer related policies for successful operation of the fertilizer supply and marketing system. These include taxation policy, farm credit policy, farm technology and input supply policies; farm produce marketing policies; fertilizer quality control policies, and data documentation policy.

XII Agroservice Marketing Concept

(a) Plan for establishing the retail depot as a source of information, seeds, equipment , chemicals, storage, credit, tools, and a market for farm produce.

(c) Assistance in acquiring appropriate inputs.

(d) Sponsorship of educational activities.

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TERMS OF REFERENCE FOR TECHNICAL SUPPORT
of
THE APPROVED FERTILIZER MARKETING AND SUPPLY SYSTEM

I Based upon the acceptance of an approved plan for marketing and supply, prior studies pertaining to fertilizer sector, and prior experience, a limited number of highly technical personnel will be required to advise, coach and train various components of the organization. As required facilities are installed, and personnel deployed, such "start up" personnel, (1) provide formal and "on-the-job" training, (2) observe and recommend adjustments during the execution of the many components of the organization, (3) expedite early implementation through their approval observations and timely actions, and (4) assure that the necessary controls are maintained.

II Initially, overall of the following will probably be required for a continuing basis:

a. Fertilizer System Manager Advisor

(1) Gives advice to Managing Director, Makerting Manager and Supply Manager.

(2) Serves as Chief Advisor on fertilizers to Zambian government organizations and donors.

(3) Serves as leader of fertilizer technical team.

(4) Assists with policy formulations

(5) Gives direct assistance to personnel selection, management and development.

b. Distribution Advisor

(1) Gives guidance to plans, organization, operations and controls of the transport modes used to move organizations products.

(2) Gives guideline on the management of inventory, storage type, size and location.

(3) Gives guidance on shipping schedules.

(4) Gives advice on required information, title, order, and monetary flow relating to fertilizers.

(5) Assists in the negotiations with carriers for transport equipment supply.

(6) Assists with documentation of the systems.

c. Marketing Services Advisor

(1) Advises Chief agronomist, Marketing Research and Development Supervisor, Educational Supervisor and the Sales Promotion Supervisor in the execution of their responsibilities.

(2) Advises Sales Manager on the management of all sales activities.

(3) Assists in the selection and training of marketing personnel.

(4) Instructs on methods and procedures for preparing the annual marketing and supply plan.

III During the course of development (1984-1994) other selected fertilizer specialists may be required on a short-term basis:

(1) Agronomic and economic researchers,

(2) Procurement and supply officers

(3) Training supervisors

(4) Production engineers

(5) Personnel Management specialists

(6) Transport Engineers

(7) Civil or mechanical engineers for construction and maintenance

(8) Geologists

(9) Finance Specialists

(10) Agricultural policy specialists

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BUDGET ESTIMATE: ZAMBIA FERTILIZER MARKETING AND SUPPLY ANALYSIS AND ACTION PLAN

Personnel Requirements and Salary	Man/Months	Cost	
Project Coordinator	2	15,000	
Marketing Specialist	4	18,800	
Fertilizer Distribution Specialist	4	18,800	
Agricultural Economist - Policy	4	17,000	
Agricultural Economist - Prices	3	13,750	
Agronomist - For Soils and Crops	3	18,000	
Fertilizer Production Engineer	3	12,300	
Sub Total	23		$ 113,650
Support Staff Requirements and Salary			
Graphics	2.0	3,000	
Editing and Word Processing		3,500	
Typist	2.5	2,500	
Clerks (2)	1.5	1,800	
Sub Total			$ 10,800
Logistics			
Per Diem 500 days @ $88 =		44,000	
Car Rentals and Driver hire (4 cars) 180 days @ 51.84 =		9,330	
Office Space Zambia 90 days @ 51.20 =		4,600	
Air tickets - International 8 round trips Zambia		20,000	
- Local trips		3,500	
Resource materials - maps, books, etc.		800	
Printing final report 500 copies		3,000	
Communications		1,000	
[illegible]		77,[illegible]	
[illegible]		29,900	

APPROXIMATE BUDGET FOR TECHNICAL SUPPORT OF ZAMBIAN MARKETING AND SUPPLY SYSTEM

	YEAR 1	YEAR 2
	$	$
Personal Services		
Salaries and Benefits including Post differential for resident Consultants(3)	247,500	259,875
Salaries Benefits for Short-term Consultants (4-man-months)	18,800	20,680
International Airfare (3 families x 4 x $3.000 + enroute expenses)	20,400	20,400
International Airfare (Short-term Consultants - (4)	12,000	12,000
Shipment of personal effects 200lbs/family x 3	15,000	15,000
Shipment of personal effects 600lbs/family x 3	7,200	7,200
Shipment of food 500lbs/family x 3	3,000	3,000
International and local travel for Resident staff	6,000	12,000
Vehicles for resident Consultants (3)	60,000	-
Vehicle operation and maintenance	2,500	2,500

	YEAR 1	YEAR 2
	$	$
Housing utilities, etc (3)	72,000	72,000
Office space @ $51.84	18,600	18,600
Office supplies and equipment	7,200	3,400
Support staff	10,800	10,800
Logistics for short-term staff		
- Per diem 120 days @ $88	10,560	10,560
- Local air travel	3,500	3,500
Administrative fee	180,271	165,030
TOTAL =	$ 695,331	$ 636,545