PN-AAV-407

46028

Cameroon Fertilizer Sector Study

Prepared by IFDC for USAID/Cameroon under contract number AFR-0510-A-00-5053-00.

May 1986

International Fertilizer Development Center/
United States Agency for International Development

International Fertilizer Development Center Muscle Shoals, Alabama U.S.A.

Table of Contents

Page

ABBREVIATIONS AND ACRONYMS vii
PREFACE. x
ACKNOWLEDGMENTS. xiii
DISCLAIMER xiii
MAJOR ISSUES IDENTIFIED BY IFDC REQUIRING
CAMEROON GOVERNMENT POLICY INITIATIVES xiv
GENERAL INTRODUCTION xx
GENERAL CONCLUSIONS. xxi

SECTION I. CAMEROON AGRICULTURE AND FERTILIZER USE. 1
Part I--Overview 1
Importance of the Agricultural Economy. 1
Domestic Agricultural Production 3
Agricultural Exports 3
Historical and Future Growth of Agriculture. 3
Factors Affecting Agriculture 5
Geology. 7
Relief 7
Hydrology. 8
Climate. 8
Temperatures 8
Rainfall 10
Natural Vegetation and Crops Grown 10
Soils. 14
Crop Production 18
The Farming Household. 18
Crops Grown. 18
Cropping Systems 19
Cultivatable Soils and Chemical Factors Affecting Fertility. 19
The Role of Fertilizers in Crop Production. 22
The Need for Fertilizers 22
Increasing Fertilizer Use by the Small Farmer. 24
Current Fertilizer Recommendations and Practices. 24
Oil Palm and Rubber. 26
Banana 26
Pineapple. 27
Sugarcane. 27
Cocoa. 28
Coffee 28
Rice 29
Food Crops 30
Cotton 31
Selection of Fertilizers--Agronomic and Economic Factors. 32
Technology of Production 32
Handling, Distribution, and Storage. 32
Selection of Nutrient Carrier--Nitrogen and Urea 33
Selection of Nutrient Carrier--Phosphate 38
Selection of Nutrient Carrier--Potash,
Sulfur, Magnesium, Trace Elements. 40
Mixed Fertilizers. 41
Selection of Most Appropriate Fertilizers--Conclusion. 43

Table of Contents
(Continued)

Page

Crop Responses to Fertilizers in Cameroon--
Physical Crop Response Data 45
Coffee 47
Cotton 52
Maize. 54
Sorghum. 61
Rice 64
Summary. 71
Crop Responses to Fertilizers in Cameroon--
Economics of Fertilizer Use 74
Arabica Coffee 74
Robusta Coffee 83
Cocoa. 86
Maize. 89
Rice 100
Sorghum. 104
Summary of Economics of Fertilizer Use 107
Research as Related to Increased Fertilizer Use Efficiency. 108
Research Priorities for Cameroon 110
Fertilizer Specific Research Needs 113

Part II--Historical and Future Trends in Fertilizer Consumption. 115
Historical Fertilizer Consumption 115
Fertilizer Product and Nutrient Use. 117
Fertilizer Use by Crop 125
Projected Fertilizer Consumption. 127
Projection Methodology 127
Development of Scenarios 129
Fertilizer Consumption Projections 134

SECTION II. FERTILIZER MARKETING IN CAMEROON. 156
Evaluation of Present Fertilizer Marketing and Distribution System. . . 157
Organization 157
Products 160
Pricing. 161
Promotion. 163
Procurement System 164
Tendering and Procurement System 165
Physical Distribution. 168
Review of Fertilizer Costs. 185
Port Costs 187
Warehousing Costs. 187
Transport Costs. 189
Fertilizer Losses. 190
Operational Costs. 193
Direct Retailing Cost of Subsidized Fertilizers. 195
Other Costs. 196
Estimation of the Costs of Fertilizers by Product and by Nutrient . . . 198
The Current Extension Service 198
Personnel Requirements to Manage the Present Fertilizer System. 201

Table of Contents
(Continued)

Page

Constraints to Fertilizer Use and Recommendations to Overcome Them. . . 203
Credit 208
Recommended Fertilizer Marketing System 208
Need for Change. 208
Concepts 209
Organization of the RFMS 211
Organizational Structure 214
Channel Functions. 214
Annual Marketing Plan. 215
Staffing 223
Phasing of Recommended Fertilizer Marketing System 223
Capitalization 227
Subsidy. 229
Savings. 229
Physical Fertilizer Distribution Factors. 232
Activities 232
Information System 236
Seasonality of Fertilizer Consumption. 238
Infrastructure and Additional Government Policy Required to Support the Recommended Fertilizer Marketing System. 240
Evaluation of the Road Network 240
Availability of Other Essential Crop Production Inputs 249
Availability of Structured Markets Where Farmers Can Sell Their Crop Products 251
Formal Training and Personnel Development Required to Manage a Fertilizer Marketing System. 251
Additional Infrastructure and Government Policy and Actions Required to Support an Effective Fertilizer Marketing System . . 255

SECTION III. TECHNICAL AND ECONOMIC EVALUATION OF FERTILIZER SUPPLY SCHEMES 259
Ammonia/Urea/DAP Complex. 260
Ammonia Process Technology 261
Urea Process Technology. 265
Diammonium Phosphate (DAP) Process Technology. 268
Raw Material Supply. 271
Plant Capacity 273
Plant Location 275
Production Economics for Ammonia/Urea/DAP Complex 276
Capital Investment Estimates 276
Production Cost Estimates. 278
Comparison of Cameroon Urea and DAP Production Costs With World Market Prices 285
Bulk Blending and Bagging 287
Definition of Bulk Blending. 287
Description of Process and Equipment 289
Plant Capacity 293
Using Urea for Bulk Blending 294

Table of Contents
(Continued)

	Page
Raw Material Supply	297
Production Guidelines and Precautions for Bulk Blending	300
A Need for Judgment	305
Cargo Size and Storage for Raw Materials	306
Plant Operation (Continuous Versus Intermittent)	310
Plant Location	311
Bagging Plant Outside of Port Boundary	312
Dockside Bagging	313
Production Economics for Bulk Blending and/or Bagging	314
Bulk Blending and Bagging	314
Dockside Bagging	325
Summary of Conclusions and Recommendations	328
Bibliography	330

Appendix A. Cameroon Fertilizer Use Projection, Scenario I
Appendix B. Cameroon Fertilizer Use Projection, Scenario II
Appendix C. Cameroon Fertilizer Use Projection, Scenario III
Appendix D. Cameroon Fertilizer Use Projection, Scenario IV
Appendix E. Crop Production Leaflets
Appendix F. Contract Between FONADER and Agents
Appendix G. Typical Tender Document Used in 1985
Appendix H. Prototype Product Specifications
Appendix I. Some Criteria for Retailer Selection
Appendix J. Rainfall Patterns in Cameroon
Appendix K. Extent of Cameroon Road Network
Appendix L. Fertilizer Law
Appendix M. Premises and Assumptions Used for Preparing Capital Investment and Production Cost Estimates
Appendix N. Scope of Work

ABBREVIATIONS AND ACRONYMS USED IN THIS REPORT

Chemicals and Fertilizers

Al_2O_3	Aluminum oxide
AN	Ammonium nitrate
Ar	Argon
AS	Ammonium sulfate
B	Boron expressed as B_2O_3
Ca	Calcium
$CaCO_3$	Calcium carbonate
CAN	Calcium ammonium nitrate
CaO	Calcium oxide
CH_4	Methane
Cl	Chlorine
CO	Carbon monoxide
CO_2	Carbon dioxide
$CO(NH_2)_2$	Urea
DAP	Diammonium phosphate
F	Fluorine
Fe_2O_3	Iron oxide
H_2	Hydrogen
H_2O	Water
H_3PO_4	Phosphoric acid
KCl	Potassium chloride
K_2O	Potassium oxide
K_2SO_4	Potassium sulfate
LNG	Liquefied natural gas
MAP	Monoammonium phosphate
Mg	Magnesium
MgO	Magnesium oxide
N_2	Nitrogen
Na_2O	Sodium oxide
NH_3	Ammonia
$NH_2CO_2NH_4$	Ammonium carbamate
$(NH_4)_2HPO_4$	Diammonium phosphate
NPK	Nitrogen (N), phosphorus (P_2O_5), potassium (K_2O)
O_2	Oxygen
P_2O_5	Phosphorus pentoxide
S	Sulfur
SiO_2	Silicon dioxide
SO_3	Sulfur trioxide
SOP	Sulfate of potash
SSP	Single superphosphate
TSP	Triple superphosphate
Zn	Zinc

Organizations

ANACAM	Syndicat des Producteurs d'Ananas du Cameroun
CAMSUCO	Cameroon Sugar Company
CDC	Cameroon Development Corporation
CFSO	
DEP	Direction des Etudes et Project, Ministère de l'Agriculture
DIRAGRI	Direction de l'Agriculture, Ministère de l'Agriculture
DPA	Direction de la Production Agricole, Ministère de l'Agriculture
FAO	Food and Agriculture Organization of the United Nations
FONADER	Fonds National pour le Developpement Rural
HEVECAM	Société Hévéa - Cameroun
IFDC	International Fertilizer Development Center
IITA	International Institute for Tropical Agriculture
INTSOY	International Soybean Program
IRA	Institut de la Recherche Agronomique
MIDENO	Northwest Development Authority
MIDO	Mission pour le Développement de l'Ombessa
MIDEVIV	Mission de Développement des Cultures Vivrières, Maraîchères et Fruitières
MINAGRI	Ministère de l'Agriculture
OCB	
ONCPB	Office National de Commercialisation des Produits de Base
PAMOL	Société Pamol Cameroun
SAFGRAD	Semi-Arid Food Grain Research and Development
SEMRY	Société d'Expansion et de Modernisation de la Riziculture, Yagoua
SEPCAE	Société d'Engrais de et Produits Chimiques d'Afrique Equatoriale
SNH	Société Nationale des Hydrocarbures
SOCAME	Société Camerounaise des Engrais
SOCAPALM	Société Camerounaise de Palmeraies
SODEBLE	Société de Développement pour la Culture et la Transformation de Blé
SODECAO	Société de Développement du Cacao
SODECOTON	Société de Développement du Coton
SOGAZCAM	Société d'Etudes du Gaz du Cameroun
SOGETRANS	Société de Gestion et de Transport
SOSUCAM	Société Sucrière du Cameroun
TLU	Testing and Liaison Unit (USAID, NCRE Project)
UCCAO	Union Central des Coopératives Agricoles de l'Ouest
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USAID	United States Agency for International Development
WADA	Wum Area Development Authority
ZAPI-EST	Zone d'Actions Prioritaires Intégrées de l'Est

Others

atm	Atmosphere (14.696 psi)
B/C	Benefit/cost
Btu	British thermal unit (0.25 kilocalorie)
CEC	Cation exchange capacity
c. & f.	Cargo and freight
c.i.f.	Cargo, insurance, and freight
CRH	Critical relative humidity
CV	Coefficient of variation
°C	Degree centigrade or Celsius
°F	Degree Fahrenheit
FCFA	Franc CFA
f.o.b.	Free on board
g	Gram
GDP	Gross domestic product
GOC	Government of the United Republic of Cameroon
h	Hour
ha	Hectare
kcal	Kilocalorie (1,000 calories)
kg	Kilogram
km	Kilometer
LSD	Least significant difference
m	Meter
m^2	Square meter
m^3	Cubic meter
meq	Milliequivalent
MIS	Management Information System
mm	Millimeter
mt	Metric ton
mtpd	Metric ton per day
mtph	Metric ton per hour
mtpy	Metric ton per year
%	Percent
ppm	Parts per million
psi	Pound per square inch
RFMS	Recommended Fertilizer Marketing System
RH	Relative humidity
TOR	Terms of Reference
US$	United States dollar
V/C	Value/cost

PREFACE

Although Cameroon is blessed with the widest range of climatic conditions and plant life of all West Africa and therefore has an extremely diverse agricultural base, most of the soils of Cameroon are of relatively low fertility.

Historically, this fact was recognized by farmers and overcome by the use of lengthy fallow periods and, to a more localized degree, by the use of crop residues and animal manures. With these systems, a stable but low level of crop production could be maintained without recourse to fertilizer.

Unfortunately, stable traditional systems are based on subsistence farming and low population densities. Ultimately, increases in crop production on low-fertility soils must be based on the judicious use of fertilizers. Effective organic matter recycling and the use of legumes can reduce the need for fertilizers but cannot replace them entirely. Over large areas, inputs of fertilizer phosphorus, sulfur, potassium, calcium, and magnesium will be essential for increasingly productive systems, and nitrogenous fertilizers, irrespective of the developments in legume production, will be the key to high yields of improved cereal varieties.

Fertilizer use in Cameroon was initially based only on the perennial export crops (coffee, oil palm, and rubber) and the annual cotton crop. Increasingly, however, farmers have been fertilizing food crops particularly the cereal crops and especially maize grown as a cash crop.

The Government of the United Republic of Cameroon (GOC) has encouraged the use of fertilizers by small farmers by giving a major subsidy on fertilizers intended for coffee production. These fertilizers have been distributed by government agencies, parastatals, and cooperatives to small farmers, particularly to the important coffee-growing areas of the west.

Current levels of subsidized fertilizer consumption are such that GOC faces enormous costs in maintaining both direct subsidies and in meeting the costs of distribution. An increase in fertilizer consumption will aggravate the situation.

At this stage in the evolution of the fertilizer sector, the opportunity arises for GOC to move into a more cost-efficient fertilizer procurement and marketing system by increasing the role of the private sector in the whole system.

Such development of the fertilizer sector will need government policy initiatives on a wide range of issues covering agricultural research and extension, fertilizer supply, and procurement/production. This study, which has identified key issues and the necessary policy initiatives needed, can be used as the basis for the development of an efficiently functioning fertilizer sector--a sector which is needed if agricultural production in Cameroon is to grow as planned.

The study, which was carried out by a team of International Fertilizer Development Center (IFDC) specialists, is the result of a series of earlier initiatives undertaken by the United States Agency for International Development (USAID)/Cameroon which drew attention to the need for an in-depth multidisciplinary review of the Cameroon fertilizer sector.

In a letter dated February 25, 1985, to the Director of USAID/Yaounde, the then Minister of Agriculture gave USAID his encouragement and support to undertake the present study which had the following specific objectives.

Fertilizer Use

1. To determine the most appropriate types and quantities of fertilizer needed for principal crops on the basis of agronomic and economic criteria.
2. To determine the actual and projected fertilizer demand by nutrient and types of products.
3. To determine the economics of fertilizer use.

Fertilizer Marketing

1. To determine the cost of fertilizers delivered to farmers by principal marketing components.
2. To identify constraints to fertilizer use in the existing marketing system and recommend procedures for overcoming these constraints.
3. To identify additional infrastructure, government support, and government policy required for an effective marketing system.

Fertilizer Supply

To evaluate the production economics of two alternative production schemes:

1. Bulk-blending and bagging plant using imported bulk materials.
2. Ammonia, urea, and diammonium phosphate complex using Cameroon natural gas reserves and imported phosphoric acid.

The scope of work, which is given in Appendix N, recognized that an efficiently functioning national fertilizer sector must be based on a fully integrated marketing system. Components of the marketing system include agronomic research and service education, product selection, sales, storage, transport, and pricing designed to best meet the needs of the Cameroon environment.

IFDC Team

Dr. D. H. Parish--Agronomist and Team Leader

Mr. G. T. Harris--Economist

Mr. N. D. Le--Chemical Engineer

Mr. P. M. Rosseau--Soil Scientist

Mr. J. J. Schultz--Chemical Engineer

Dr. V. L. Sheldon--Transport Specialist

Mr. L. B. Williams--Marketing Specialist

The IFDC team arrived in Yaounde on October 14, 1985. This report is based on their findings following visits to each of the provinces and discussions with the relevant government agencies, parastatals, private sector companies, the Food and Agriculture Organization of the United Nations (FAO), and World Bank.

Reports

The following reports based on the Cameroon fertilizer sector study are available.

1. Cameroon Fertilizer Sector Study—333 pages (English)
2. Etude du Secteur des Engrais au Cameroun—333 pages (French translation of #1)
3. Cameroon Fertilizer Sector Study—Appendices (Annexes)
4. Executive Summary—Cameroon Fertilizer Sector Study--34 pages (English)
5. Sommaire Executif—Etude du Secteur des Engrais au Cameroun—34 pages (French translation of #4)

ACKNOWLEDGMENTS

The IFDC team wishes particularly to acknowledge the support of M. Felex Nkonabang, Sub-Director, Direction de l'Agriculture (DIRAGRI); M. Richard Moulu, Director of Studies and Operations, Fonds National pour le Développement Rural (FONADER); M. Simon Koudja, Economist, Direction des Etudes et Projects/Ministère de l'Agriculture (DEP/MINAGRI); and M. James Ndoko, Agro-Economist, FONADER, in arranging in-country itineraries and meetings and in giving the IFDC team the benefit of their expert knowledge of the Cameroon agricultural and fertilizer sectors.

DISCLAIMER

Statements and conclusions listed in the IFDC report do not necessarily represent or reflect USAID/Cameroon's position concerning fertilizer sector issues in Cameroon; nor does the report reflect an official position of Cameroon. The statements and conclusions in the report are the sole responsibility of the authors of the report.

MAJOR ISSUES IDENTIFIED BY IFDC REQUIRING CAMEROON GOVERNMENT POLICY INITIATIVES

To increase food and cash crop production in Cameroon requires improved technology. Along with high-yielding varieties, proper crop fertilization is an essential component. An efficient fertilizer and marketing system is required to provide farmers with this critical input to improved technology which can bring about increased production.

To establish and operate an efficient fertilizer supply and marketing system, there are crucial fertilizer policies that need positive government support. To facilitate review for possible implementation, the crucial fertilizer supply and marketing issues are summarized under four categories--research on fertilizer use, supply, marketing, and infrastructure. Policy recommendations are made for each issue.

Issues and Recommendations

I. Interministerial coordination on policy issues

The inefficiency of the present fertilizer sector stems, in part, from a lack of policy coordination among the various ministries involved.

Recommendation--Establish an interministerial fertilizer committee with the objectives of increasing policy coordination and defining a coherent fertilizer policy to improve the overall efficiency of the fertilizer sector.

II. Research on fertilizer use issues

Food-crop production will stagnate unless sound yield-increasing technologies are more widely adopted. The rational use of fertilizer is a necessary technological input for higher crop yields. However, because of the enormous number of farm sites and cropping systems, the current blanket recommendations are unsatisfactory. Individual farmer recommendations are also impractical. Therefore, domains of similar characteristics (soils, crops, etc.) must be used as the basic unit for recommendations.

A. Relevant yield-increasing technologies must be identified on the basis of specific recommendation domains.

Recommendation--Establish farm-level research to identify nutrient needs for important crops and to formulate fertilizer use recommendations (type, quantity, time, and method of application) for specific situations. Crop production areas must be stratified into recommendation domains on the basis of characteristics which influence crop response to fertilizer. Characteristics to be considered in defining a recommendation domain are crop/variety, mono- or mixed cropping, cropping sequence, yield goals, organic material management, soil properties, and climatic conditions.

B. In many areas, the fertilizer products currently used, the rates at which they are applied, and the way that they are applied are not the most cost effective in terms of food-crop yields.

Recommendation--Establish an accelerated national cash and food-crop production research program. The program should link research (agronomists, soil fertility specialists, and agricultural economists) with extension work, the fertilizer marketing system, and the farmers in adapting recommendations to provide solutions to farmers' crop production problems. A crop production package usable by the farmer will be the output of this activity.

III. Supply issues

It is critical to have an economical and timely supply of fertilizers that will meet the needs of individual Cameroon farmers.

A. Present procurement procedures are so complex and cumbersome that fertilizers often arrive in-country too late and above world market price.

Recommendation--The Government should agree to eliminate the bureaucracy involved in fertilizer procurement and further agree to the establishment of capable fertilizer companies that will operate on a commercial basis to procure and distribute fertilizers.

B. Cameroon has natural gas reserves which could be used as fuel and feedstock for the production of nitrogen fertilizers (ammonia and/or urea).

Recommendation--The Government should continue to study and monitor the fertilizer situation and initiate production investment when national production is economically feasible.

C. Foreign exchange can be saved and local labor utilized to reduce the cost of fertilizer and to ensure a timely supply through in-country bagging and bulk-blending operations.

Recommendation--Bulk fertilizers should be imported and bagged in-country. Bulk blending should be studied and implemented when it is economically feasible and the demand is established.

IV. Marketing issues

An efficient fertilizer marketing system that will make the right products available to farmers in a timely and cost-effective manner and promote effective use is a key to increased agriculture productivity.

A. The present Government-operated fertilizer distribution system has played an important role in introducing and creating a demand for fertilizers in Cameroon. Further modernization of the agriculture sector requires a dynamic and responsive fertilizer marketing system.

Recommendation--Facilitate the creation of a private company that has the authority and capability to purchase, process, and market the required fertilizers. Authorize the company to operate on a profit and loss basis with a minimum of government restrictions.

B. At present the fertilizer forecasting system for specific grades and amounts is ineffective.

Recommendations--Establish a system to project fertilizer consumption at the retailer level that can be revised periodically as conditions change.

C. Fertilizer/crop price ratios are very important factors in determining the level of fertilizer consumption. For example, projections with the present marketing system indicate that consumption in 1995 will reach 186,000 mt with present fertilizer/crop price ratios and will reach only 147,000 mt if price ratios become unfavorable.

Recommendation--Monitor these price ratios for each crop and develop policies that give farmers the economic incentives to use fertilizer and increase crop production.

D. Pricing Policies--Prices received by the farmers have been so unfavorable for some crops, such as coffee, that production has stagnated. Government's attempt to alleviate this has resulted in subsidized fertilizer. This present subsidized system has not been able to overcome the stagnation. It has also been a very expensive system.

Recommendation--Government should study and monitor cost of production of various cash and food crops and attempt to influence the pricing structure in order to ensure favorable incentives for increased agricultural production and allow for the subsidy of fertilizer to be gradually phased out over 5 years.

E. Promotion--Fertilizer promotion is inadequate. The transfer of information on fertilizer use and benefits needs to be improved and intensified at the farmer, extension, and government policymaking levels. Proven media for the transfer of technology, i.e., bulletins, leaflets, billboards, demonstrations, field days, farmer meetings, etc., are not in use on a wide scale.

Recommendations--(a) Establish educational programs, i.e., demonstrations, farmer meetings, literature and visual aids, as an integral part of the marketing system to educate farmers especially those producing food crops; (b) train extension staff, retailers, and others on the use, marketing, and production of fertilizer products; (c) identify and support research on factors limiting crop yields.

F. Quality Control--There is a need to establish a uniform fertilizer quality control law. Because of the lack of uniform and practical quality standards, the calls for tenders fail to adequately specify the product, its composition, packaging, labeling, inspection procedures, analyses, and delivery conditions. Quality control legislation is inadequate and may place a constraint on fertilizer use through loss of farmer confidence because of failure to meet guaranteed analyses, weights, and physical characteristics.

Recommendations--The Government should develop an agency (possibly within the Ministry of Agriculture) that has an understanding of fertilizer technology and a strong field operational capability to formulate fertilizer quality control legislation and implement it to ensure value received both to the farmer and country.

G. Personnel Development--There is need for improved management in all aspects of fertilizer supply and marketing, especially in systems management, arranging transportation, warehousing, product selection, promotion, data collection, documentation, and retailing. Retailers are not adequately informed on fertilizer technology and are not advising farmers on the correct use of fertilizers.

Recommendations--The recommended fertilizer marketing system will select personnel and train them on all aspects of fertilizer management and marketing. Retailers will be trained to advise farmers on the correct use of fertilizers. Agricultural extension field workers should receive updated information on fertilizer technology on a continual basis. Fertilizer technology should be included in curriculum in agricultural colleges.

H. Too Few Fertilizer Retailers--There are too few retailers offering fertilizers for sale to farmers. The distance many farmers have to travel for fertilizer is excessive and costly. Many villages with produce markets and other business activities do not have a fertilizer retailer although one is needed and could be justified.

Recommendations--The recommended fertilizer marketing system will select an appropriate fertilizer retailer for all major markets and provide an incentive for the retailer to carry out all marketing functions which include sales promotion, education, and storage.

I. Warehousing--Suitable warehousing for fertilizer storage is not available in all areas. In the very humid conditions in the Douala ports, special warehousing is needed that can be closed to better protect the fertilizers. Warehousing and storage facilities are not in the best locations to serve retailers and farmers. In many cases coffee warehouses are used for fertilizer storage. The warehouses are not especially designed for fertilizers nor are they located to specifically serve the fertilizer industry.

Recommendations--The Government should make land and facilities for warehouse locations available to fertilizer companies at a fair market value and encourage their construction where storage facilities for fertilizer are inadequate.

J. Other Essential Inputs--Other essential inputs to complement the fertilizer package are not always available at the retail level. These include high-yielding varieties of seed, plant protection

chemicals (insecticides and herbicides), and farming equipment. Lime is a missing soil amendment that is needed to provide calcium and correct soil acidity. With out the complete package optimum yields will not be forthcoming. A package approach to food-crop production is needed.

Recommendations--Develop an action program to encourage private companies to develop sources of all essential inputs and offer for sale to farmers through the fertilizer retailer network.

V. Infrastructure issues

There are key elements of infrastructure that are required for the efficient development of an agriculture sector. Some of the required infrastructure is discussed below.

A. Roads and Rail--Railroads and primary and feeder (farm to market) roads are limited in many sections of Cameroon. Lack of roads places a constraint on the physical movement of fertilizers from port to farmers and movement of farm produce to market.

Recommendations--A program for developing and improving railroads, primary roads, and farm-to-market roads between major agricultural producing areas and population centers should be carried out on a priority basis.

B. Port Draft and Unloading Equipment--Port draft in Douala is only 7.8 m and is too shallow to allow the berth of vessels carrying the most economical tonnage of imported fertilizers (10,000-20,000 mt). Less than full vessel loads result in uneconomical freight rates and higher fertilizer cost. Unloading equipment in the Douala port results in damage to fertilizer bags and loss of materials. The equipment and facilities are also not suitable for the unloading of bulk materials and in-port bagging.

Recommendations--Utilize full loads of the maximum size that the port facilities will accommodate until such time as the port can be expanded to accommodate larger, more economical vessels. The GOC should assist the companies in making land and facilities available for the construction of required fertilizer warehouses and unloading equipment.

GENERAL INTRODUCTION

Almost all the agricultural areas of Cameroon need varying inputs of fertilizer nitrogen, phosphorus, sulfur, potassium, calcium, magnesium, and trace elements for increased crop yields.

Sound development of fertilizer use starts with a knowledge of the farmer's situation--his farm size, cropping systems, socioeconomic background, education, and the fertility of his soils--and the fertilizers needed if he is to improve his economic returns from farming.

However, fertilizers can contribute to increased crop production only where there are adequate and efficient physical and institutional infrastructures to procure, distribute, and sell fertilizers to farmers fully educated in their correct use. Development of an effective fertilizer sector by Cameroon must be based on the concept of integrated marketing which brings together agronomic and economic research on fertilizers; the extension activities associated with both farmer education and the sales promotion of fertilizers; the production, procurement, and distribution of the needed fertilizers; and the establishment of an organization to monitor achievements, identify constraints to fertilizer use, and take or recommend needed actions to remove these constraints.

Section I is essentially an overview of those items affecting farmer interest in fertilizer and their effective use for increased crop production. In Section 1, Part II, the available data on historical fertilizer use are analyzed and used to project probable future supply needs. As the level of efficiency of the marketing system will be reflected in decreasing or increasing fertilizer consumption growth rates, various scenarios ranging from the simplest scenario of no change in the existing system to scenarios using a fully integrated commercial type fertilizer operation have been used.

Section II develops the theme of the integrated marketing approach to fertilizer sector development and makes recommendations for developing an integrated self-sufficient marketing system.

Section III looks at ways of reducing the costs of fertilizer products needed by the marketing system. The possibility of reducing the outflow of foreign exchange caused by importing fertilizer through development of local production facilities is also examined.

GENERAL CONCLUSIONS

Given the large land area and the wide range of climatic conditions, Cameroon has great potential for agricultural and particularly crop production development. Such development is needed in order to meet the food and fiber needs of the growing population and to strengthen agricultural exports, which are a major source of foreign exchange. The soils of Cameroon are of relatively low fertility, and varying amounts of fertilizer nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, and trace elements are needed for improved crop growth.

Fertilizer is only one component of the crop production packages that must be put together in order to increase crop production. However, in Cameroon where crop production is mainly from nonirrigated upland agriculture, fertilizer use when combined with good agronomic practices can give significant increases in crop yields in the short term. This being said, fertilizer is a bulky and relatively expensive input which gives economic benefits only when correctly used in terms of fertilizer product selection, rate of application, timing, and placement methodology.

More than 105,000 mt of fertilizer was used in Cameroon in 1984/85. Of this fertilizer, 40% was sold at nonsubsidized prices through the private sector, including SODECOTON, and was used on industrial and export crops. The remaining 60% or 64,000 mt was procured and distributed as subsidized fertilizer principally to the small coffee farmer who uses it for both his coffee and his food crops. Fertilizer consumption is projected to reach only 186,000 mt by 1995 if the present marketing system and present fertilizer crop price ratios are maintained.

The more expensive nonsubsidized fertilizers are used in accordance with generally sound agronomic guidance as to fertilizer types and rates of application. The subsidized fertilizers are used primarily on coffee and maize or other food crops. The traditional coffee fertilizers are 20-10-10 and ammonium sulfate (AS), although urea is being increasingly imported to replace AS.

Per unit of nitrogen, ammonium sulfate is expensive. Where sulfur deficiency is not a problem, ammonium sulfate should be replaced by urea for both coffee and food crops. On maize and other food crops, 20-10-10 can be

economically replaced by a high-phosphate starter fertilizer such as 10-30-10-5S combined with the use of urea as a topdressing for the cereal crop.

Results based on research-managed trials show that nonsubsidized fertilizer is profitable with specific crops and that subsidized fertilizer is generally profitable. Low crop prices are a major constraint to fertilizer use even when using subsidized fertilizer on Arabica coffee. Research on the development of fertilizer recommendations for the small farm situation needs to be intensified and must incorporate socioeconomic components. In addition, there is a need for involvement of extension staff with research staff and a wider appreciation by both research and extension staff of marketing problems related to inputs and crops produced. Fertilizer must be seen as an essential but costly input to be used in the most cost-effective way possible. Good research well coordinated with the extension service is one way to achieve this objective.

The nonsubsidized fertilizer sector is fairly efficient and operates at no direct cost to the Government of Cameroon (GOC) except for its foreign exchange costs. Greater efficiency and savings can be achieved by buying in shipload lots, by reducing the time between purchase and use, and by flexibility in the selection of fertilizer products.

The subsidized component of the fertilizer sector in Cameroon is currently experiencing numerous supply and marketing constraints which are creating increasing costs to the GOC and holding down farmer demand for fertilizer. A cost-effective and self-sufficient system to service the large number of independent small farmers can be established. To be more operationally efficient and at the same time to facilitate the removal of the subsidy burden to the GOC, the responsibility for the management of the subsidized sector should be transferred to an organization having authority, responsibility, and accountability for its effective performance. Through an integrated marketing effort and the assurance of a fair crop price to the farmer, GOC subsidy on fertilizer can be eliminated.

The system recommended for the subsidized fertilizer sector closely links supply and marketing. It increases cost-effectiveness by ensuring efficient delivery of the correct fertilizers to farmers more fully educated in their use. The marketing component of the system integrates sales, promotion/education, market research, distribution, price, and personnel development with processing/procurement to achieve the maximum savings to the national economy

and to the farmer. The system is flexible and linkages with existing institutions are established. A network of retailers to enhance the crop production education of small farmers is a key component. The system features strong educational efforts to expedite the transfer of fertilizer and crop production use technology to small farmers. It places the appropriate fertilizers at locations close to the farms in time for use. Fertilizer consumption by 1995 under this new system is projected to be 20% higher than if the present marketing system continues and nutrient usage would be 25% higher.

A significant savings in the cost of fertilizer (about US $35/mt [FCFA 14,000/mt]) can be achieved through improvements in procurement. To obtain these savings it will be necessary to order larger lots of fertilizer (5,000 mt minimum) to obtain more favorable purchase prices from the manufacturers and more economic ocean freight rates. Efficient procurement is heavily dependent upon an effective fertilizer marketing system to (1) provide reliable demand forecasts, (2) minimize the number of required grades, and (3) smooth the flow of material from the port to the farmer through an effective distribution and retailing network.

Additional savings, up to a total of about US $55/mt or about FCFA 22,000/mt, can be obtained by importing relatively large lots of fertilizer (5,000 mt minimum) in bulk and bagging the material locally. This system will also require the strong support of an effective marketing system for the same reasons as indicated above.

Bulk blending of imported bulk materials is a logical extension of the above supply options. However, this option should only be implemented after the economics of bulk imports and local bagging are clearly demonstrated and a market for bulk blends is established.

During the evolution of the recommended system, 326,000 mt of fertilizers would be supplied with a reduction in distribution costs of FCFA 14.48 billion (US $36.2 million), a supply savings of FCFA 6.42 billion (US $16.05 million) and major cost reductions for the GOC due to reduction and eventual elimination of the fertilizer subsidy.

Exploitation of Cameroon's natural gas reserves by producing urea for the export market (a separate issue evaluated in this study) appears to be feasible if the GOC adopts a natural gas pricing policy that will result in a urea production cost that is competitive in the world market. An in-depth study is needed to more closely identify the cost and world-scale marketing factors

that will determine the feasibility of such a project. A small-scale urea production complex for supplying only Cameroon's domestic needs is too uneconomic to warrant further consideration.

SECTION I

CAMEROON AGRICULTURE AND FERTILIZER USE

PART I--OVERVIEW

Agriculture is and will continue, in the medium run, to be the backbone of the Cameroon economy. The poor economic situation of the average farmer and the lack of strong physical and institutional infrastructure has constrained the growth of the agricultural sector. The current situation as regards fertilizer use development reflects the general agricultural situation.

In this section the importance of agriculture to Cameroon is reviewed as are those factors--climate, soil, and farmer situation--which influence crop production and fertilizer use practices.

The need for fertilizers and the constraints to their use by the large estate and the small farmer are discussed in general terms. Current fertilizer recommendations and practices for the key crops are presented and the selection of appropriate fertilizers is discussed in some depth. An analysis in terms of physical yield effects and the probability of fertilizer use based on available fertilizer research results is then given. Recommendations for needed fertilizer research follow.

Finally, in Part II, the historical data on fertilizer consumption are analyzed and used to project future fertilizer needs. As economic, institutional, and physical factors affect fertilizer use, future demand projections are made with different scenarios based on economic returns from fertilizer and on unimproved and improved marketing systems.

Importance of the Agricultural Economy

Figure I-1 gives the administrative divisions of the Republic of Cameroon. The total area of Cameroon is 47.5 million ha, of which 15% is classified as arable land or land in permanent crops. The population, which is growing at 2.4%/annum, reached 9.1 million in 1983/84. Seventy-nine percent of the population is classified as agricultural.

The agricultural sector is and always has been the most important component of the Cameroon economy despite the increasing importance of oil in recent years. A wide range of ecological zones allows Cameroon to have a very

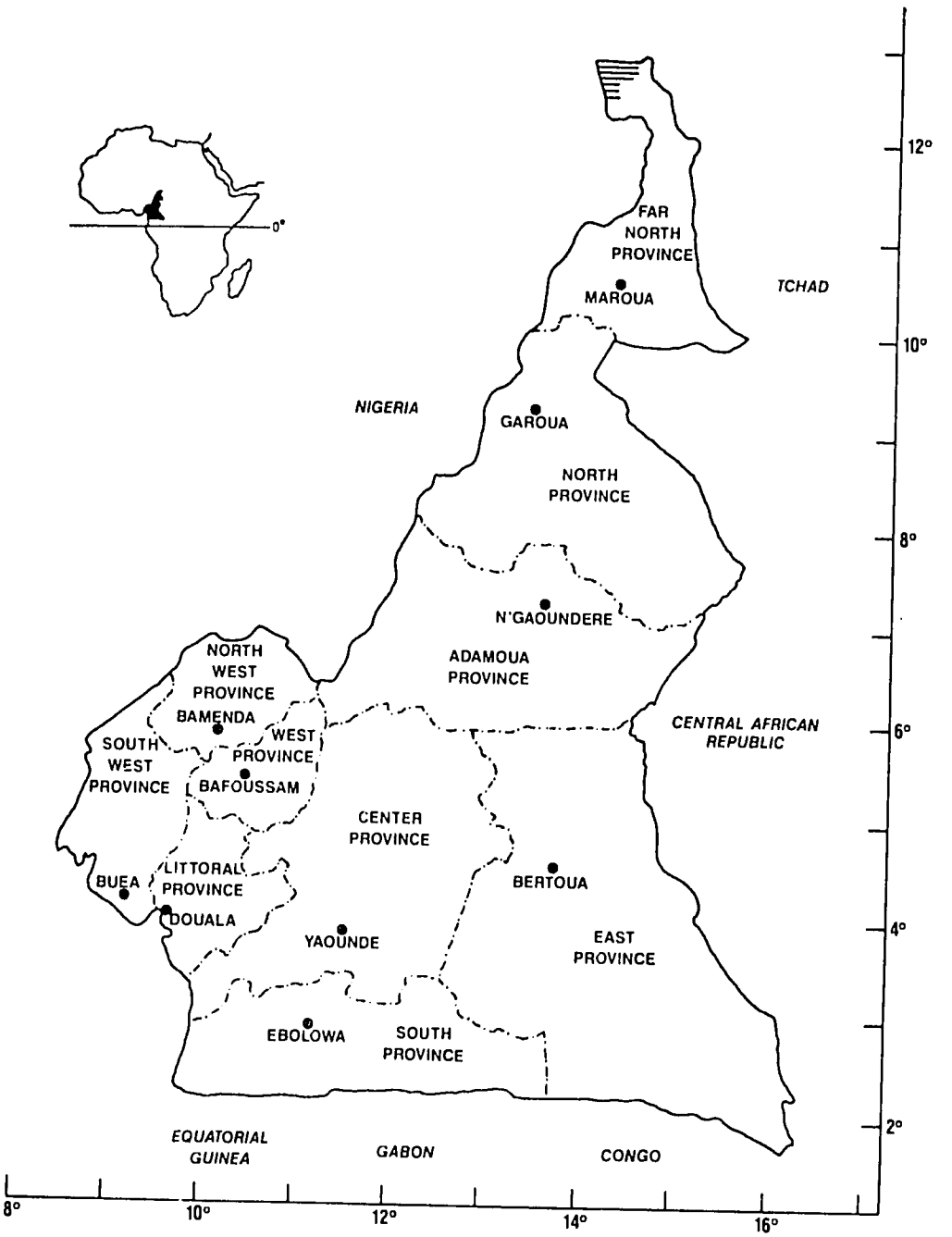


Figure I-1. Administrative Division of Cameroon.

diversified agriculture ranging from export crops such as coffee, cocoa, cotton, and rubber to food crops such as maize and rice (Table 1-1). More than 73% of Cameroon's labor force is employed in agriculture. The agricultural sector is composed of both "traditional" agriculture and "modern" agriculture. Traditional agriculture includes 1.1 million smallholder farmers who plant an average of 1.7 ha, whereas the modern sector includes parastatals as large as 40,000-50,000 ha. The traditional secto till accounts for most of the total agricultural production in Cameroon.

Domestic Agricultural Production

A major role of the agricultural sector is to produce food to feed the nation. In the past the Cameroon agricultural sector has done this quite well, and the nation is virtually self-sufficient in food production.

Agricultural Exports

Cameroon is an important exporter of cocoa, coffee, cotton, rubber, and tobacco. The area, yields, and total production of these crops are given in Table I-2. In 1982/83 exports of cocoa and cocoa products accounted for about US $150.5 million while coffee accounted for US $136.5 million. Coffee and cocoa vie each year for first place in agricultural exports. Farm-level sales of cocoa, coffee, cotton, and tobacco totaled FCFA 108 billion in 1984 (Table I-3).

Historical and Future Growth of Agriculture

In the fifth Five-Year Plan, growth of the agricultural sector was projected to reach 5% annually. This has not been achieved. Before 1980, the agricultural sector accounted for about one-third of the gross domestic product (GDP) and three-fourths of total export earnings. Because of the growing importance of oil in the country's economy, the relative importance of agriculture has declined. Latest estimates put the sector's contribution at 22% of GDP and less than 21% of export earnings. Despite the importance of agriculture to Cameroon, it was allocated only a small part of the total investment in the fifth Five-Year Plan. Within the agricultural sector, the modern sector has been heavily supported with subsidies and investments compared with the traditional sector. Smallholder production of a number of crops has stagnated and yields of export crops have fallen short of expectations. Major reasons for this lack of growth are inadequate input, supply, and technical crop production packages; insufficient producer prices for export crops; marketing problems; lack of

Table I-1. Cameroon: Food Crop Area Production, Yield, and Sales

Crop	Hectares	Production (mt)	Yield (kg/ha)	Sold (%)	Total Sales (million FCFA)
Maize	205,700	408,740	1,987	23	8,430
Sorghum/millet	373,500	207,660	556	7	1,439
Rice	19,200	50,530	2,626	61	2,477
Cassava	115,300	1,385,000	12,011	30	19,284
Taro/macabo	98,100	191,800	2,102	23	2,342
Yams	23,100	109,420	4,900	29	2,699
Irish potatoes	23,800	41,980	1,765	43	923
Beans	91,800	54,460	593	37	2,738
Peas	5,862	6,910	1,215	32	274
Groundnuts	134,100	99,180	740	NA	6,039
Sugarcane	2,958	122,810	41,518	46	2,390
Plantain (bunch)	53,300	63,620	1,194	32	19,448
Banana (bunch)	30,400	49,850	1,640	32	7,150
Oil palm (liter)	50,200	82,630	1,646	33	8,108
Total food crops	1,227,300	-	-	-	83,741

Source: 1984 Agricultural Census.

Table I-2. Export Crop Area, Yield, and Production, 1984 Units

Crop	Planted (ha)	Yield (kg/ha)	Production (mt)
Cocoa	276,400	381	114,000
Arabica coffee	101,100	392	35,400
Robusta coffee	154,100	885	118,830
Cotton	80,800	1,017	82,210
Rubber	NA	NA	NA
Tobacco	2,600	846	2,200

Source: 1984 Census of Agriculture. Rubber not available.

Table I-3. Farm Value of Major Export Crops

Crop	Farms With Crop Sales (number)	Total Value of Sales (million FCFA)	Average Value Selling Farm (FCFA)
Cocoa	222,200	47,678	215,000
Arabica coffee	166,800	10,742	64,000
Robusta coffee	173,500	38,227	220,000
Cotton	124,400	10,225	820,000
Tobacco	21,600	1,070	50,000
Total	-	107,943	-

Source: 1984 Census of Agriculture.

feeder roads; and land tenure constraints. Rural incomes lag behind those in the cities.

Current agricultural growth rates projected by the World Bank indicate that Cameroon may become an agricultural importer by the end of the decade. The most recent in-depth analysis of the country's food situation in Cameroon (Ministry of Economic Affairs and Planning, 1981) showed that, for all foods, Cameroon will move from a position of full self-sufficiency or slight excess demand to a position of serious shortages by the end of the century if present trends in food production and consumption continue. Figure I-2 shows current trends.

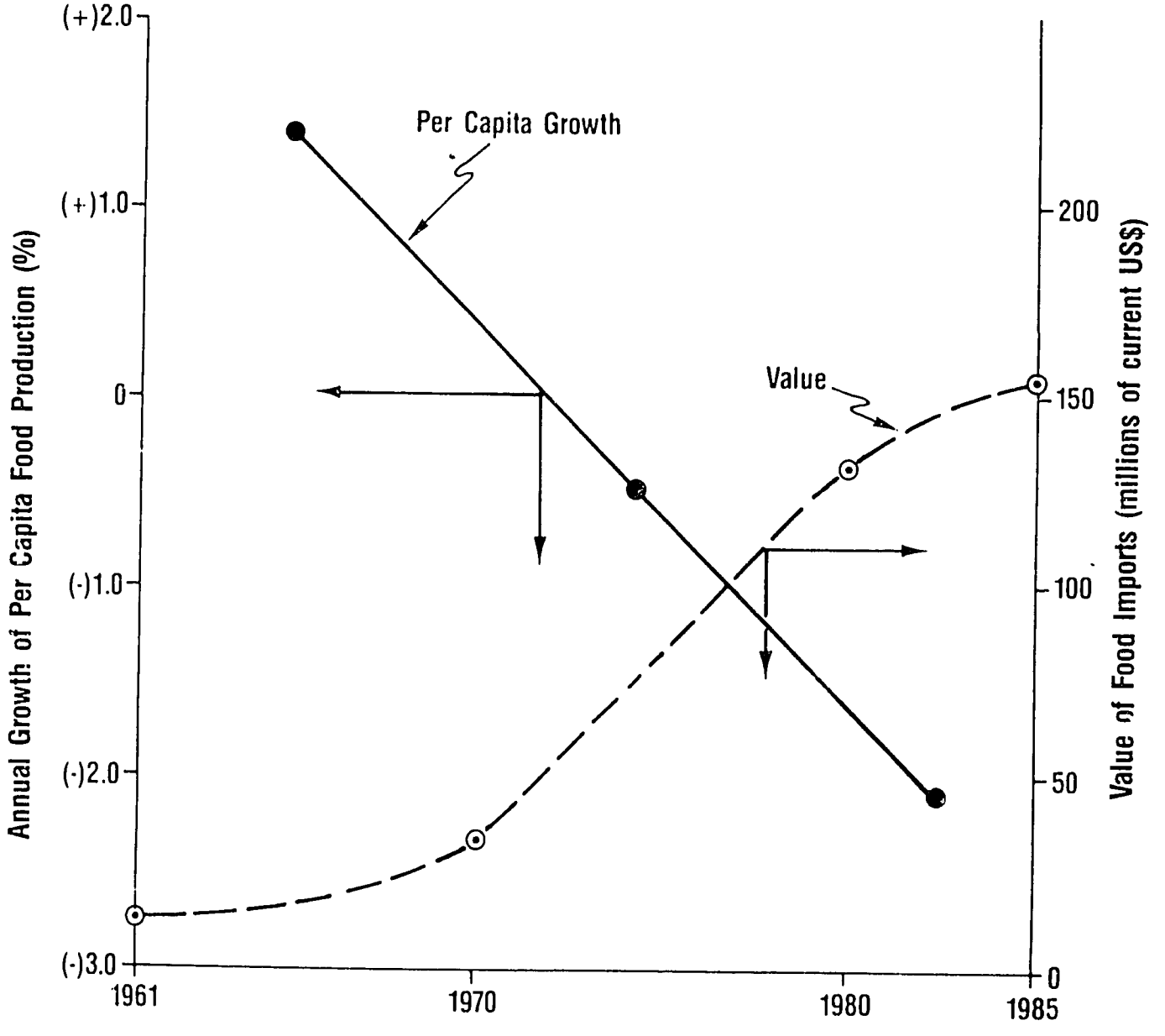
Oil production in Cameroon is expected to peak in 1985 at 7.6 million mt and is projected to decline to 6.1 million mt by 1990. As this occurs, the importance of the agricultural sector to the national economy in terms of export earnings will increase. Thus, a strong agricultural sector is needed in the future to replace oil revenues as well as to meet national food demands. The fifth Five-Year Plan addressed this issue in attempting to stress investment in the agricultural sector, particularly by increasing food production by the smallholder.

Factors Affecting Agriculture

Agricultural production is the end product of human initiative based on exploiting the climate, topography, soils, and plant ecology to meet man's needs for food, fiber, and fuel. The human element in agricultural production is motivated by socioeconomic considerations. Cameroon has a population with a wide spectrum of cultural, social, and economic norms.

The combination of climate, geology, and physical relief determine both the edaphic and ecological features of a country. Cameroon has a wide range of climatic, geological, and physical relief features; therefore, the country has an extremely varied edaphic and ecological base and, as a result, a wide range of agricultural crops and production systems.

The level of crop production per unit area reflects all crop production factors, many of which (insolation, temperature, etc.) are uncontrollable. Other factors such as the genetic potential of the crops grown and correct agronomic practices, including the maintenance or improvement of soil fertility, can be changed if sufficient economic incentive exists.



Source: World Bank.

Figure I-2. Per Capita Growth in Food Production and Value of Food Imports—Cameroon.

The following descriptions briefly outline those factors mentioned which explain the diversity of crops grown in Cameroon.

Geology

The African basement complex covers 80% of the surface area while sedimentary and volcanic rocks cover several small areas.

The basement complex consists of two major groups of rocks: folded metamorphic gneiss, mainly Precambrian, which forms the major part of the South Plateau and the more recent granites of the Western High Plateau, the Adamaoua region, and the Mandara Mountains.

The sedimentary formations that occur in the coastal region and in the Bénoué depression are Cretaceous and Tertiary, and those that occur in the coastal subsidence zones and the Chad Plain are Quaternary.

Volcanic massifs (mainly basalt) occur in the west and southwest, the Adamaoua, and the Mandara Mountains.

Relief

The coastal lowlands, bordered by the Western High Plateau and by the South Cameroon Plateau to the north, form an area not exceeding about 90 m in height.

The vast Southern Cameroon Plateau, which averages 650 m elevation, forms part of the northern and western border of the Congo Basin.

The Western High Plateau is made up of numerous terraces ranging from 1,000 to 1,800 m with scattered volcanic masses rising to 3,000 m. The volcanic massif starts in the Gulf of Guinea with Mount Cameroon (4,070 m) and terminates with the Mandara Mountains.

The Adamaoua, with an average elevation of 1,100 m, occupies the center of the country. The northern boundary of the Adamaoua covered by the volcanic massifs (reaching 2,460 m) falls abruptly to the Benoué Basin.

The Bénoué Basin, a vast basin to the north of the Adamaoua, opens to the northeast onto the Chad Plain. The center of the Basin is broken by buttes and mesas while on the northern and southern fringes inselbergs or massifs surrounding the Adamaoua and the Mandara Mountains stand out.

The Mandara Mountains cover the least area and are the lowest of the High Plateau. The massif is isolated between the Benoué Basin and the Northern Plain. The northern and southern parts of the chain are the most mountainous reaching a maximum of 1,440 m.

The Northern Plain extends between the Mandara Mountains, the Logone and Chari Valleys, and Lake Chad. The region bordering the Mandara massif is the only part which is flood-free; the rest of the plain is almost totally flooded in the rainy season.

Hydrology

Most of the rivers rise in the Adamaoua and in the Southern Plateau and are split into four basins: (1) the Atlantic Basin which comprises three river systems--the Sanaga and its tributaries, the coastal rivers of the west (Cross, Mungo, Wouri, and Didamba), and the southern coastal rivers (Wyong, Lokoundje, and Ntem); (2) the basin of the Congo (Kadei and Ngoko); (3) the Niger Basin (Bénoué and Faro); and (4) the Lake Chad Basin (Logone) and various other lakes.

Climate

Spread between latitudes 2°N and 13°N Cameroon has two distinct climatic zones.

To the north of the sixth parallel, there are distinct wet and dry seasons. The southern part of this area, the Sudanian zone, benefits from a 6-7 month rainy season, whereas for the more northerly Sahelian zone the rainy season lasts less than 5 months.

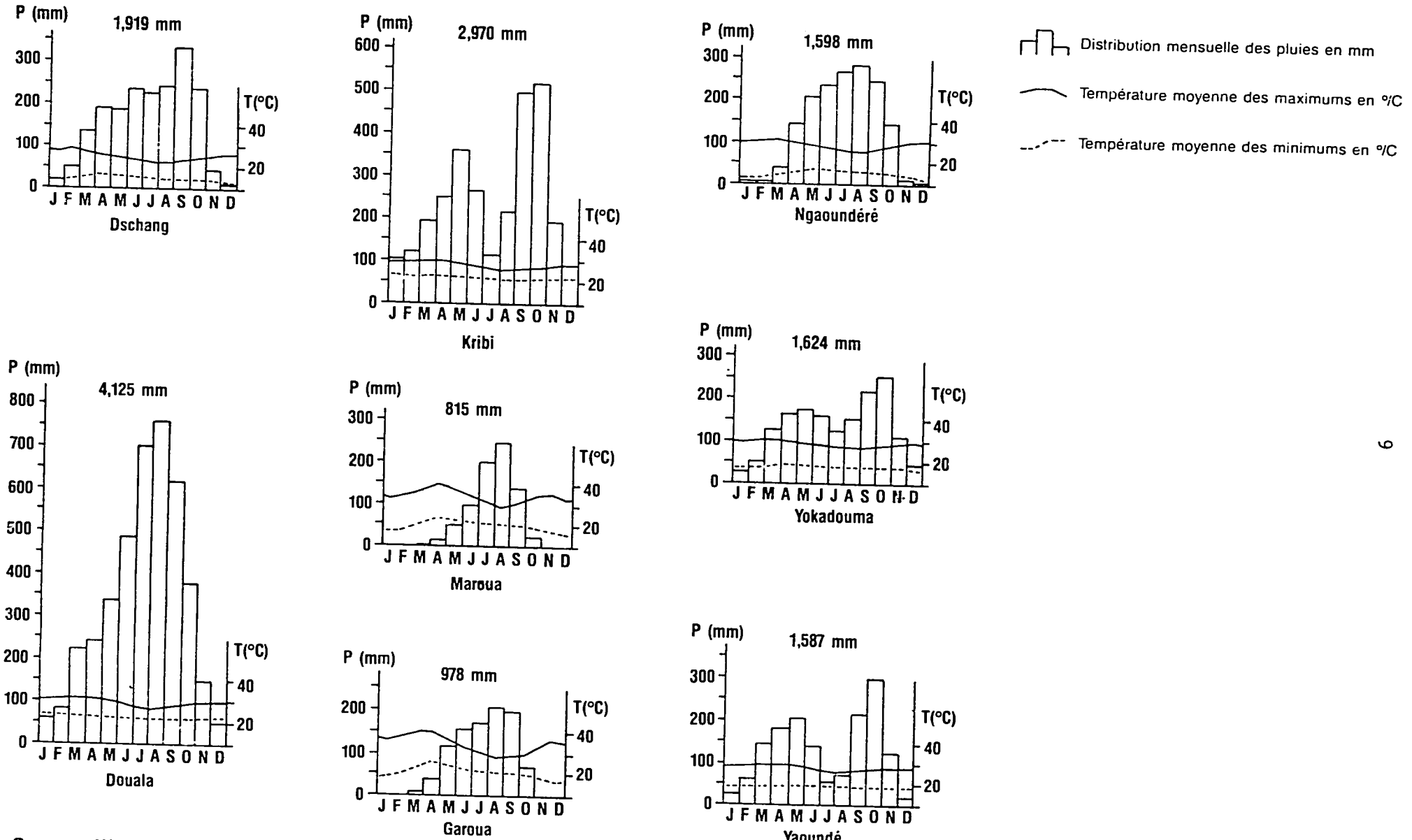
To the south of the sixth parallel, the climate is equatorial and again of two types: the classical Guinean zone with two slightly different wet and dry seasons annually and the Cameroonian Guinean zone which is caused by the mountain massifs of the west. This latter has a rainy season of 9 months and a short dry season of about 3 months.

Temperatures (Figure I-3)

The spread of the country over the 11° of latitude leads to significant differences between the north and the south, and the large differences in elevation also have their effect.

In the south the temperatures are relatively constant: at low elevation the mean is 25°C with a small annual variation of 3°C and a diurnal variation of only 5°-10°C.

In the north temperature variations are more marked: at low elevations the mean annual temperature rises to 28°C with an annual variation of 10° to 15°C, according to latitude, and a strong diurnal variation of about 20°C.



Source: Westphal (1985).

Figure I-3. Rainfall Distribution and Mean Maximum and Mean Minimum Temperatures.

Rainfall (Distribution, Figure I-3, and Annual, Figure I-4)

Rainfall diminishes from south to north as a function of latitude and from west to east as a function of distance from the ocean and the more mountainous regions of the west.

The coastal area rainfall ranges from 4,000 mm at the mouth of the Sanaga on the Nigerian border to 2,700 mm at the Equatorial Guinea border.

Inland from the coast total rainfall drops quite rapidly. The coastal areas and the dorsal mountains receive a copious rainfall of more than 2,000 mm except in a few sheltered areas.

The major eastern and southern areas have rainfall between 1,500 and 1,700 mm.

North of the Adamaoua the isohyets fall rapidly from 1,500 to 400 mm (Figure I-4).

The rainiest month of the year follows the southward movement of the intertropical front. Maximum monthly rainfall is in August in the north, in September in the Adamaoua, and in October, without exception, in the south-center and southeast. The monsoon gives maximum rainfall in July and August in the massifs directly exposed to the prevailing winds, and in the low areas September and October are the wettest months.

The 2,000-mm isohyet outlines the area affected by the monsoon. The rainfall within this isohyet varies enormously with up to 10,000 mm of rain at Dbundscha.

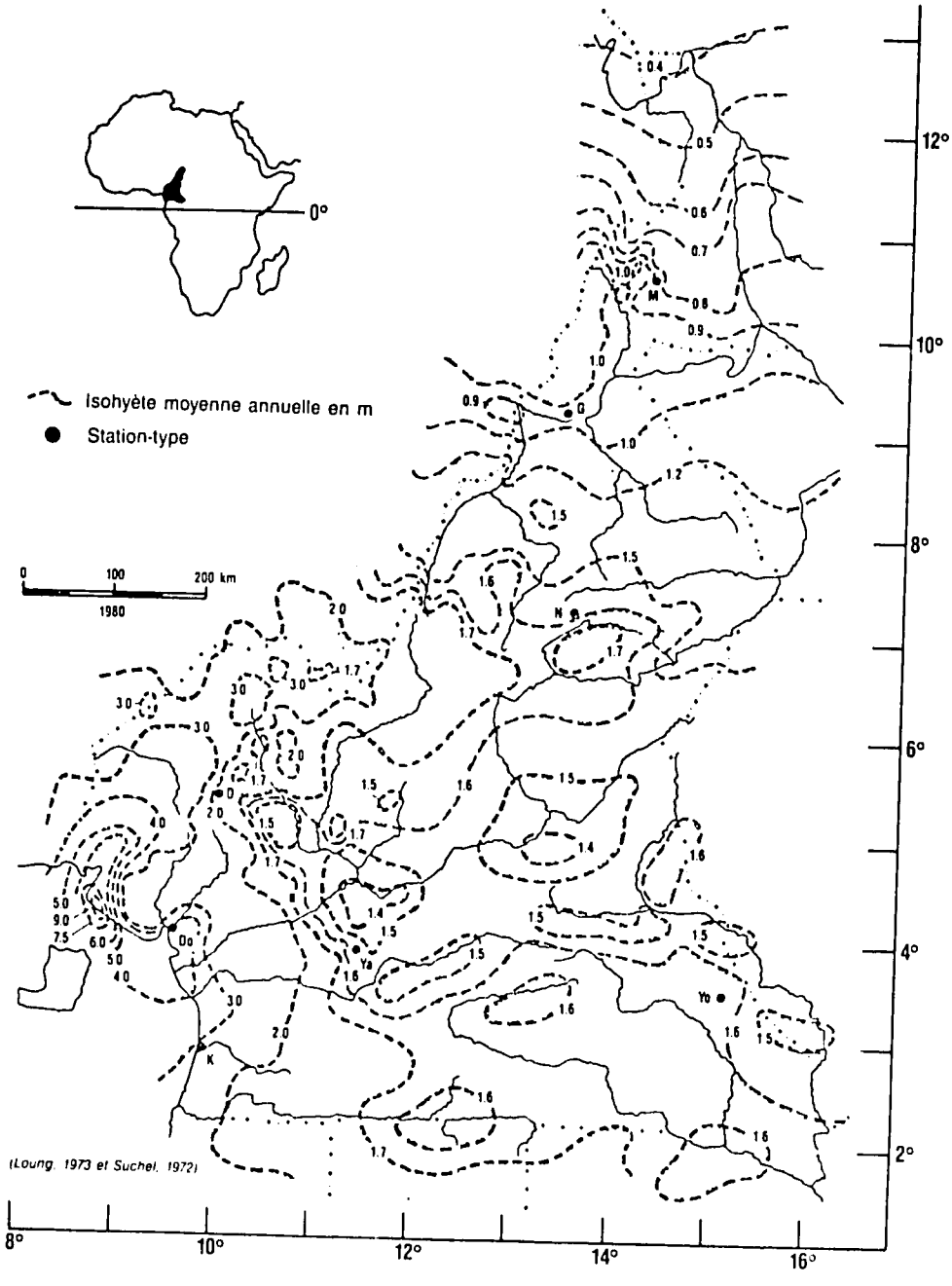
Natural Vegetation and Crops Grown

The natural vegetation of Cameroon is richly diverse reflecting the climatic and edaphic features of the country (Figure I-5).

This diversity has been exploited by the Cameroon farmer to develop a series of complex farming and cropping systems which, for centuries, have exploited the soils and moisture regimes available in a most effective manner.

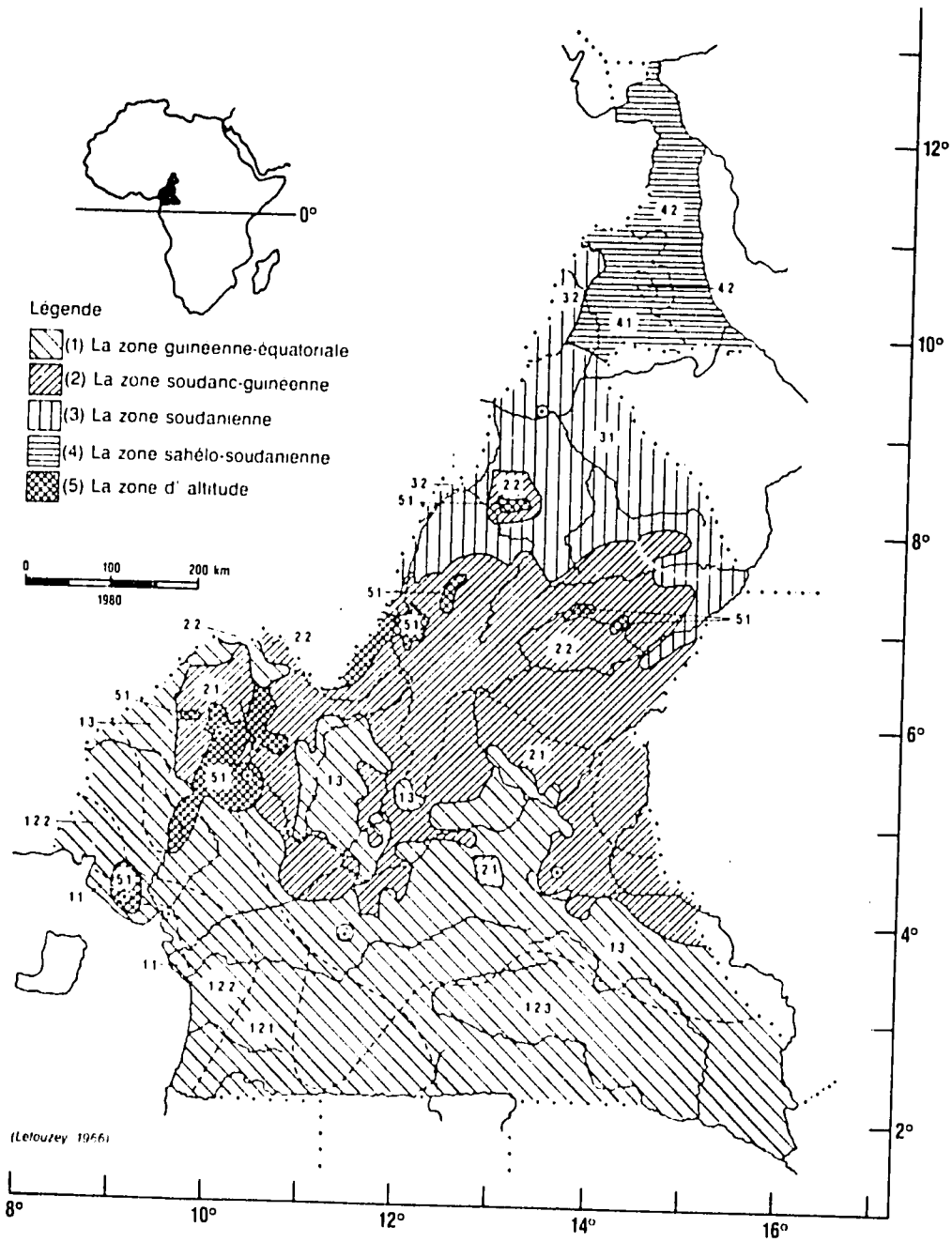
Figure I-6 shows how the major edapho-ecological zones of Cameroon affect the food crops grown. This map, however, gives only a general indication of the great complexity of the cropping systems developed and used by most Cameroon farmers today. These systems have stood the test of time, but they are now increasingly being abandoned in many areas because of increased population pressures and a growing cash crop orientation of the farmers.

The major perennial cash crops, coffee, cocoa, oil palm, rubber, and bananas grow in the Guinean zone while cotton grows in the northern Sudanian and Sahelian zones.



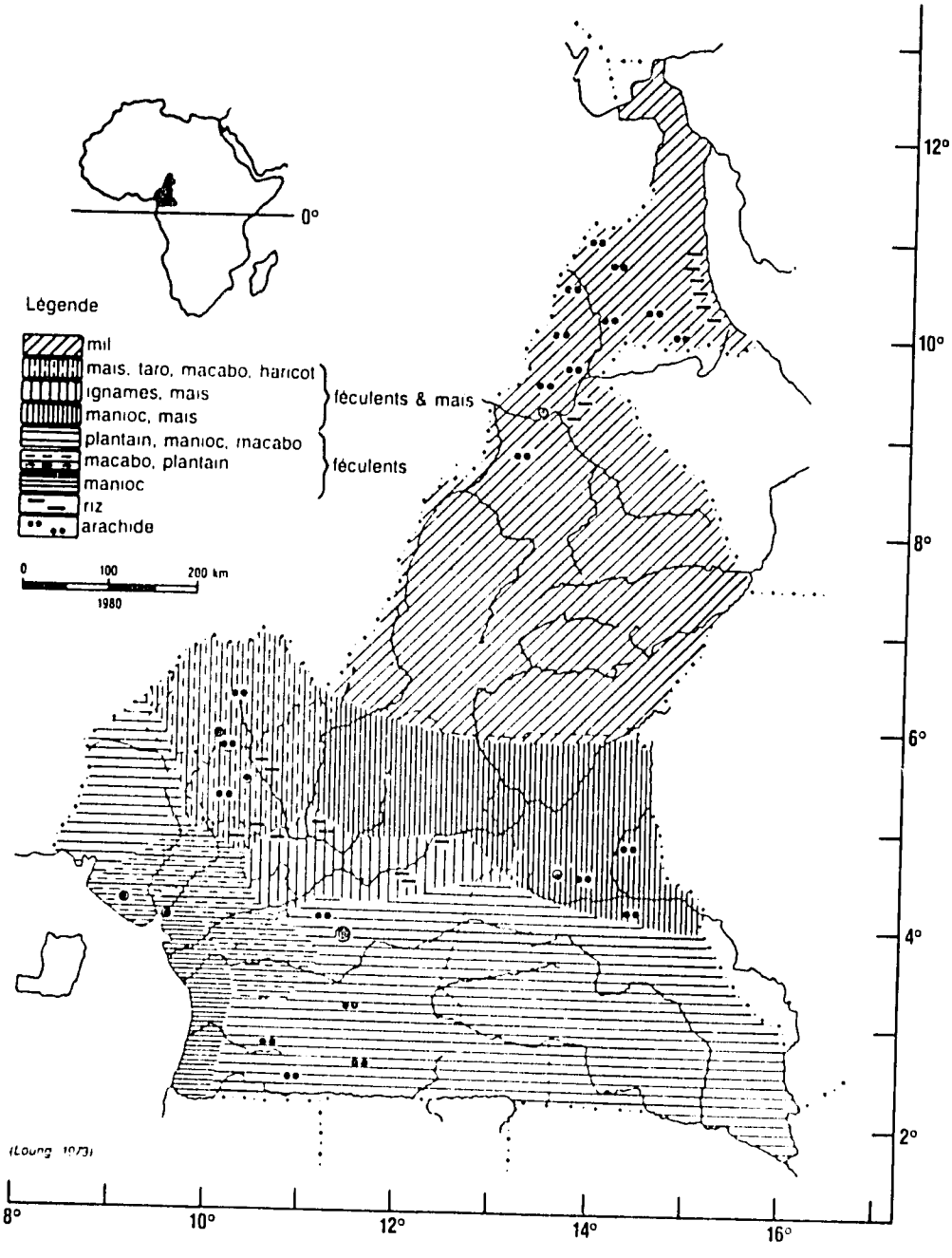
Source: Westphal (1985).

Figure I-4. Mean Annual Rainfall in Cameroon.



Source: Westphal (1985).

Figure I-5. Natural Vegetation of Cameroon.



Source: Westphal (1985).

Figure I-6. The Principal Food Crops of Cameroon.

Soils

The soils of Cameroon have been mapped by FAO/United Nations Educational, Scientific, and Cultural Organization (UNESCO) (Figure 1-7 and legend). The soil units used for the map have been described by Awa (1975) as follows.

Acrisols (A)--Acrisols are very acid, highly weathered, and leached soils. They are characterized by a low base saturation and have rather sandy surface horizons and clayey subsurface horizons. Nearly all Acrisols of Cameroon are Orthic Acrisols (Ao), which is connotative of the common types of Acrisols. Most of these soils are Sols ferrallitiques typiques, jaunes et brun-jaunes according to the French classification system. They are acid and chemically very poor. They have a low development potential and are usually very hard to improve and to bring into good agricultural potential. The nutrient status is very low, whereas their capacity to retain phosphate is high. To develop these soils, fertilizers will be required, and the cost of these will be one of the important factors determining the use of these soils. Most of the Acrisols are found in central Cameroon.

Ferralsols (F)--Ferralsols are highly weathered, red and yellowish red soils with a high content of iron and aluminum oxides. They are acid, generally very deep without much horizon differentiation, and clayey in texture. These soils are physically very good, but chemically they are poor and deficient in nutrients. Most of the Ferralsols in Cameroon are Orthic Ferralsols, which is the common red type of Ferralsol. These soils cover most of the slightly undulating areas of the Central-South Province. These soils include the Sols ferrallitiques typiques, rouges sur roches acides, moyennement et fortement desaturés according to the French classification system.

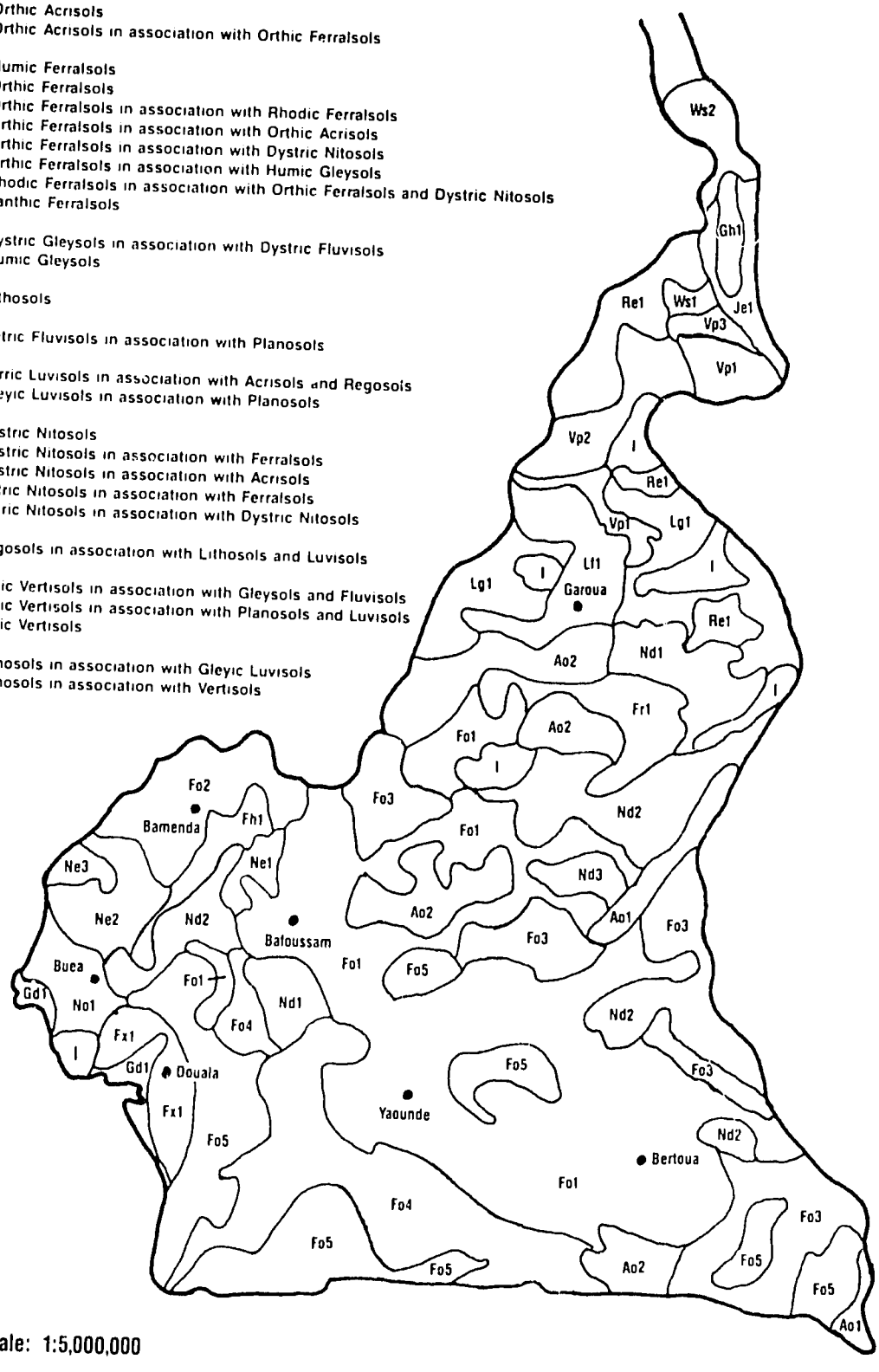
Although these soils are low in nutrients, they generally have a fairly good development potential and are suitable for a wide range of cropping systems, provided a good management including the use of fertilizers is practiced.

On the Cameroon highlands of the western provinces Humic Ferralsols are found--Sols ferrallitiques humifères. They are characterized by an appreciable amount of organic matter and a low base saturation. These soils provide good agricultural land, but they are highly susceptible to erosion. Soil conservation practices, therefore, are very necessary.

The Rhodic Ferralsols are those Ferralsols with dark red colors and a very clayey texture; they are mainly formed from basic rocks--Sols ferrallitiques faiblement désaturés. They are less weathered and have a fairly good nutrient status. Together with the Humic Ferralsols they represent the highest potential

Legend

Ao1	Orthic Acrisols
Ao2	Orthic Acrisols in association with Orthic Ferralsols
Fh1	Humic Ferralsols
Fo1	Orthic Ferralsols
Fo2	Orthic Ferralsols in association with Rhodic Ferralsols
Fo3	Orthic Ferralsols in association with Orthic Acrisols
Fo4	Orthic Ferralsols in association with Dystric Nitosols
Fo5	Orthic Ferralsols in association with Humic Gleysols
Fr1	Rhodic Ferralsols in association with Orthic Ferralsols and Dystric Nitosols
Fx1	Xanthic Ferralsols
Gd1	Dystric Gleysols in association with Dystric Fluvisols
Gh1	Humic Gleysols
I	Lithosols
Je1	Eutric Fluvisols in association with Planosols
Lf1	Ferric Luvisols in association with Acrisols and Regosols
Lg1	Gleyic Luvisols in association with Planosols
Nd1	Dystric Nitosols
Nd2	Dystric Nitosols in association with Ferralsols
Nd3	Dystric Nitosols in association with Acrisols
Ne1	Eutric Nitosols in association with Ferralsols
Ne2	Eutric Nitosols in association with Dystric Nitosols
Re1	Regosols in association with Lithosols and Luvisols
Vp1	Pellic Vertisols in association with Gleysols and Fluvisols
Vp2	Pellic Vertisols in association with Planosols and Luvisols
Vp3	Pellic Vertisols
Ws1	Planosols in association with Gleyic Luvisols
Ws2	Planosols in association with Vertisols



Scale: 1:5,000,000

Source: FAO UNESCO
Soil Map of the World
Sheet VI Africa

Figure I-7. Schematic Soil Map of Cameroon.

within the Ferralsols. These soils are found around Ngaoundere and in the western provinces. The Xanthic Ferralsols are the sandier and yellower members of the Ferralsols, found around Douala--Sols ferrallitiques typiques jaunes. These soils are less suitable for agriculture; consisting mostly of quartz and sesquioxides, they dry out easily and require high amounts of fertilizer to produce acceptable levels of yields.

Fluvisols (J)--Fluvisols are developed from recent alluvial deposits--Sols d'apport sur alluvions. These young soils do not show much horizon differentiation, but generally they have a good level of organic matter and fertility, particularly the Eutric Fluvisols. These soils form a very fertile group of soils worthy of being given priority for development. Their nearness to a water source gives them added advantages in an irrigation program. Most of the Fluvisols cannot be mapped on small-scale maps, and they occur mostly in association with other units.

Gleysols (G)--Gleysols--Sols à gley are formed from unconsolidated materials exclusive of recent alluvial deposits, and they show hydromorphic properties. Most coastal soils covered with a mangrove vegetation belong to this unit. Because these soils suffer from frequent flooding, high water tables, or both, they require very costly reclamation work for their agricultural development. The Gleysols of the river valleys may be suitable for rice production. The Gleysols of Cameroon are mostly Dystric Gleysols, or Gleysols with a relatively low fertility status, and Humic Gleysols, which have a considerable amount of organic matter.

Lithosols (I)--Lithosols are soils which are shallow to very shallow over continuous coherent hard rock. They occur normally in areas with steep mountain slopes in the Cameroon highlands and the Adamaoua massif. Their agricultural value is low, although some of them, like those around Mount Cameroon, are associated with young volcanic soils which have a very good development potential.

Luvisols (L)--Luvisols are characterized by an accumulation of clay in the subsurface horizons--Sols tropicaux lessivés. These soils are found mostly in the North Province, south of Garoua. The Ferric Luvisols--Sols ferrugineux lessivés--are those Luvisols with ferric properties, i.e., many coarse, red-colored mottles. These soils have a sandy texture and a relatively low organic matter content. Their possibilities for development are not good. The Gleyic Luvisols--Sols à pseudo-gley de profondeur--are Luvisols characterized by

problems of excess water. In Cameroon these soils have rather sandy texture, low organic matter contents, and are not very favorable for development.

Nitosols (N)--Nitosols are deep dark red ferrallitic soils developed mostly on old basic volcanic rocks. They are generally very clayey, well structured, and relatively rich in organic matter with a fair to good fertility status. These soils should give good response to fertilizers. They include the Sols ferrallitiques typiques sur roches basiques, moyennement désaturés. In Cameroon, these soils are among the most cultivated and utilized, and they are found notably in the western provinces and the Ngaoundere area.

The Dystric Nitosols, the less fertile subunits, have relatively low base saturation percentages, whereas the Eutric Nitosols have higher base saturation values. Both soils occur generally in association with Ferralsols and Acrisols.

Planosols (W)--Planosols are soils of level areas with light-colored loamy surface horizons overlying a slowly permeable, dense, clayey subsurface horizon, showing hydromorphic properties and poor drainage. In Cameroon these soils are found exclusively in the Extreme North Province--les sols "hardé"--and they are characterized by some sodium in the exchange complex. These soils--Solodic Planosols--are Sols à pseudogley minéraux, sols à alcalis et les solonetz solodisés. They have unfavorable physical peoperties and are very difficult to manage.

Regosols (R)--Regosols are soils from unconsolidated generaliy coarse-textured materials without much horizon differentiation. These soils are the Sols mineraux bruts d'erosion et les sols peu évolués d'erosion. They occur particularly in the north (Mandara massif, around Maroua and northeast of Ngaoundere). These soils are generally shallow, sandy, very dry, and low in organic matter content, with limited possibilities for development.

Vertisols (V)--Vertisols are dark-colored clayey soils with a swelling clay. In Cameroon, most of the Vertisols are very dark colored Pellic Vertisols. They occur in the north on the Logone Plain, and in the Benoué Valley in association with Gleysols and Fluvisols.

Some of these soils are more or less hydromorphic, particularly the ones of the Logone Plain, which are subjected to frequent flooding. When not hydromorphic, these soils are intensively used and have a relatively good development potential although they are difficult to manage. The hydromorphic Vertisols are limited to irrigated rice cultivation.

Crop Production

The Farming Household

Agricultural production in Cameroon comes almost entirely from small farm families. The total area cultivated by a family is from 1 to 3 ha, planted partially in food crops and partially in cash crops. The food produced is essentially for subsistence, and it is this pattern which the government hopes to change as the food needs of the expanding urban population grow.

These small farm households are poor. The World Bank estimated in 1982 that families with less than 1 ha of land had a total income (earnings plus the market value of their subsistence crops) of only one-half of the poorest paid nonagricultural worker. It was estimated that at least 2.5 ha of cultivated land was needed to obtain a total income equivalent to that of the nonspecialized urban worker. Government interest in the small farmer arises not only because of his potential to increase food production but also because of the opportunity of increasing labor demand in the rural areas which would alleviate rural unemployment, mitigate rural-urban migration, and raise rural incomes.

With a sound marketing economy, the potential for developing improved technologies that bring about substantial increases in productivity is much greater than under the more restrictive conditions surrounding the food self-sufficiency orientation of farming families.

Large areas exist in Cameroon where application of low-input technologies can increase yields and help to reduce the fallow period needed for soil fertility restoration. Fertilizer may not necessarily be a component of the crop production package, for example, in the sparsely settled forest regions.

In other areas, however, particularly where there is population pressure, fertilizer will be needed if yields are to be increased. Where a reliable cash crop market exists, the combination of labor availability and good marketing infrastructure will lead to a rapid increase in production based on fertilizer use.

Crops Grown

Given the wide range in climatic conditions, agricultural production is very diversified, and unlike most of Africa, Cameroon can maintain food self-sufficiency given a modicum of effective government encouragement. Table I-1 gives the most recent statistics of crop production. Export bananas, sugarcane, oil palm, and rubber are grown as well-managed industrial estate

crops. Cotton is grown in the north by small farmers under the tutelage of SODECOTON.

The major export crops, cocoa and coffee, are produced mainly by small farmers as is the important cash crop maize.

Cropping Systems

Farm size varies from 1 to 3 ha with the food crops being essentially grown as subsistence crops. Coffee, cocoa, and cotton are the cash crops.

Increasingly food is being sold off the farm wherever roads exist. The traditional system of the man looking after the cash crop and the woman looking after the food crops has held back the introduction of improved technology for food-crop production. But as food crops are increasingly sold off the farm, the food crops will come to be regarded as cash crops, particularly if the farmer receives poor returns on his traditional cash crops.

This change has already occurred to a significant degree in the more densely populated western coffee-growing areas where coffee fertilizer is widely used on food crops. In the cotton areas the residual effects of fertilizer applied to the cotton are particularly appreciated by the farmer who follows cotton with maize and who thus can be fairly easily encouraged to use nitrogenous fertilizer on maize for sale as a cash crop.

Where there is no pressure on the land, traditional shifting cultivation practices are common. Where population pressure has led to "formally" owned patches of land, almost continuous cropping occurs. Mono-crops of sorghum or millet are common in the north; in the North West and West Provinces, and particularly around Bafoussam, the plots are more of the garden type with a great complexity of spatial organization and sequence of planting of crops facilitated by the 9-month wet season.

Cultivatable Soils and Chemical Factors Affecting Fertility

The areas of cultivatable soils by soil group and the soil fertility constraints associated with these soil groups are given in Table I-4. The data are from the FAO-University of North Carolina data base.

Soils of the northern region generally are low in organic matter, and response to nitrogen fertilizer can be expected. In contrast, in the forest zone responses to nitrogen may not be obtained during the first 2-4 years after clearing of dense forest but may occur in the first year after clearing thicket-shrub vegetation. Progressively higher rates of nitrogen are needed to maintain high yields with prolonged cropping of all soils.

Table I-4. Cameroon--Cultivatable Soils and Chemical Factors Affecting Fertility

Soil Group	Cultivatable Area[a]	Gley	Low CEC	Al Toxicity	Acid	High P Fixation	Low K Reserve
	('000 ha)						
Acrisol	2,925	38	-	2,925	-	2,887	2,925
Andosol	301	-	-	-	135	-	-
Arensol	247	-	247	-	-	-	-
Cambisol	302	-	-	61	241	-	-
Ferralsol	24,933	-	862	24,309	624	2,215	24,933
Fluvisol	685	-	-	-	39	-	-
Gleysol	2,293	2,293	-	-	83	-	-
Histosol	419	419	-	-	419	-	-
Luvisol	2,702	918	-	-	2,702	-	-
Nitosol	6,512	-	-	5,768	744	-	6,512
Planosol	1,009	1,009	-	-	-	-	-
Podzol	19	-	-	-	19	-	-
Regosol	1,366	-	-	-	47	-	-
Solonchak	34	34	-	-	-	-	-
Solonetz	10	10	-	-	-	-	-
Vertisol	1,217						
TOTAL	44,975	4,784	1,109	33,063	5,053	5,102	34,370

a. Excludes only Lithosols and Plinthic Ferralsols from total land area.

Source: FAO. University of North Carolina Data Base.

The major soil fertility constraint for crop growth is the low level of phosphate in most soils. Those soils with aluminum toxicity, the acid soils, and the high P-fixing soils are all deficient in phosphate (see Table I-4), meaning that 80% of the cultivatable soils of Cameroon are low in phosphate.

As would be expected, therefore, phosphorus responses are common on both forest and savanna soils. On most soils, low rates of P_2O_5 (20-40 kg/ha) are adequate for optimum yields. Good residual P responses in the years following application also are observed on soils with low phosphate-fixing properties. One implication of this is that high rates of application of P_2O_5 used for the cotton crop result in yield benefits to the following food crop.

South of the 6° parallel, soils are low in potash in comparison with soils farther north. However, potash deficiency in crops, at least under more traditional agriculture, is a function of the degree of organic matter recycling.

In the savannah zone, soils lose organic matter rapidly when they are cultivated, and since farmers traditionally do not practice good crop residue management, lower levels of potassium are found. In contrast, under the traditional shifting cultivation practices of the forest zone, there is effective organic matter recycling, and nutrients leached from the surface layer of the soil are recycled through the complex subsoil root system.

Intensive agriculture, with the removal of large amounts of potash in the harvested portion of the crop, will need potash applications to maintain yields, and the potash status of crops should be continually monitored to ensure that adequate potash is being used.

Sulfur deficiencies have been observed on maize and are of potential importance for legume crops. Sulfur deficiencies would be expected to develop over wide areas of the north if non-sulfur-containing fertilizers are used. This is a result of the low organic matter levels, poor organic matter and crop residue management, and the low quantities of sulfur in rainfall. About 7-15 kg/ha of sulfur appears adequate to correct any deficiency. Sulfur is included in the cotton fertilizers.

Zinc deficiencies have occurred on maize in the north. Zinc applied at 1-2 kg/ha corrects this problem.

Boron deficiency is often observed on cotton and sometimes on groundnuts. Boron is included in all cotton fertilizers.

With increasing population pressure and a shortening of the fallow periods due to increased cropping intensities, soil fertility will decline. The decline may be less in the savanna areas and at the forest-savanna boundary (Nye and Greenland, 1960; FAO, 1973; Jones and Wild, 1975) than for the typical soils

of the forest zone where the higher levels of adsorbed aluminum in the root zone of these soils lead to poorer growth of most crops.

A major critical factor for the future development of a fertilizer-based high-yield crop production system is the large area of land with actual or potential aluminum toxicity. This toxicity can be alleviated by good organic matter recycling and by the use of plant ash (burning), which is a traditional method. The selection of plant varieties tolerant of high-exchangeable aluminum levels is a modern palliative. Unfortunately, fertilizer use (nitrogen) exacerbates the problem because of soil acidification effects. A national agricultural lime policy is needed to overcome this problem.

Besides a decline of nutrient status, other factors contribute to diminished returns from intensified traditional farming. Weed infestations may be as important as nutrient depletion.

Much information exists on nutrient and yield decline with continued cropping (Nye and Greenland, 1960; Sanchez, 1976). It has been well established that appropriate fertilizer use can not only arrest the decline but also maintain yields at high levels (Kang et al., 1977; Sanchez, 1979). Economic restrictions may occur, however, particularly in the more acid soil areas unless cheap lime is readily available.

The Role of Fertilizers in Crop Production

The Need for Fertilizers

Given good genetic plant material and sound agronomic practices, water and soil fertility are the keys to high crop production levels. The importance of water in crop production cannot be overstressed, but irrigation plays only a minor role in Cameroon crop production. The agricultural future lies in the rainfed areas, and improvement in soil fertility at the farm level is a key element for maintaining and improving crop yields.

Drought is often a factor in some of the rainfed areas. However, drought should not be overemphasized. Even for the Sahel area drought is not the primary problem; poverty of the soil is the problem. Throughout Cameroon, low-fertility soils are a major constraint on crop production.

Soil fertility management is a complex issue, and although the farmer is interested primarily in his profit in the short run, the government must be concerned with the total fertility of the soil resources of the nation and not just in maintaining or increasing fertilizer use by pricing policies.

Organic matter recycling and the use of legumes are generally regarded as essential if soils are to remain productive and if dependency on fertilizer use is to be lessened. Organic matter recycling is labor intensive and must be developed by the farmer himself; the government role here is encouragement of the farmer by education and financial reward in terms of attractive crop prices.

Fertilizers are used to make a profit. They make a profit because without them the soil is incapable of supplying the nutrients needed for the desired level of crop yields.

Fertilizers are expensive ex-factory, and their distribution and storage costs are very high because of their seasonal use and bulky nature. By careless management or the use of the wrong fertilizer, the farmer can turn a potential profit source into a net loss and waste both his restricted reserves and national foreign exchange.

Fertilizers can contribute to increased crop production only in areas with adequate physical and institutional infrastructures. Physical infrastructure requirements include adequate road, transport, and storage facilities; institutional infrastructure needs include good crop and input marketing services including credit and an adequate information base. In Cameroon, therefore, increased national crop production will come initially from those rather restricted areas having a sound infrastructure able to deliver fertilizers to farmers who will use them in a cost-effective manner.

Under Cameroon conditions, an increasingly important impact of fertilizer on food-crop yields can be expected with the cereal crops and particularly with maize, which requires a high level of soil fertility for good yields.

The root crops--cassava, yams, cocoyams, and sweet potatoes--are not generally fertilized. The present varieties and cultural practices are essentially low input systems where yields can be improved by better agronomic practices without the need for purchased inputs. The same situation applies to plantains.

Leguminous crops, particularly groundnuts and soybeans, respond well to fertilizer phosphate.

The plantation crops--oil palm, rubber, tea, coffee, bananas, and sugarcane--all need well-balanced fertilization in order to be profitable. Under peasant conditions, however, unless the standard of management is good, fertilizer use may well be uneconomical.

Increasing Fertilizer Use by the Small Farmer

Fertilizer use in Africa has not developed as many planners hoped it would. If faults are to be identified, then probably the key failing has been the lack of farmer service in terms of guidance and customer service.

Perhaps the most informative report on factors affecting fertilizer use growth rates for food-crop production comes from India (Desai, 1982). The following quotation from Desai is particularly apt at this stage in the development of fertilizer use in Cameroon.

> In India, actual total fertilizer consumption has been substantially less than the economic potential for it; and fertilizer prices have been administratively controlled. Under these circumstances, it would be incorrect to interpret the time series of total fertilizer consumption within a framework of demand analysis only, relating it to the agroeconomic variables behind farmers' demand for fertilizer in order to identify the forces governing it. The pace of growth in total fertilizer consumption would also be governed by the processes that convert the potential into actual farmers' demand. This would include development of an adequate and efficient distribution system, efforts to promote fertilizer use on different crops, and increased availability of fertilizer.

Experience from most developing countries shows clearly that cheap fertilizer does not often help the poorer farmers. African governments have tended to focus on the use of subsidies to reduce fertilizer costs and therefore increase their use. However, under any combination of conditions a sound fertilizer marketing system as described in Section II is a sine qua non of increased fertilizer use.

Current Fertilizer Recommendations and Practices

Fertilizer use in Cameroon falls into three major categories of users:

1. The industrial or large estates growing oil palm, rubber, bananas, tea, and sugarcane. This group pays the full market price for fertilizers.
2. The farmers working with SODECOTON who receive fertilizers from SODECOTON to be used as part of a complete production package. These fertilizers are also paid for at full market price by SODECOTON. Although they may be sold at discounted price to the farmers, this subsidy is recovered in the cotton crop price paid to the farmers.

3. The coffee growers (both Robusta and Arabica), who are mainly smallholders, with some larger plantations also involved. (Notable among the latter is the CFSO which is a full-scale industrial-type plantation with more than 1,000 ha of Robusta). The fertilizer for coffee growers receives the full government subsidy.

Additionally, there are a host of government-sponsored small farm schemes, notably those of SEMRY in the north which grows rice, and those of the plantain and banana growers who essentially supply the urban areas of Douala and Yaounde, which also receive subsidized fertilizer.

Current fertilizer recommendations and practices for the various industrial and export-oriented crops, namely oil palm, rubber, and coffee (Arabica and Robusta), have been based on years of development work by the major French research organizations, i.e., parent organizations. The French crop physiologists Lagatu and Maume, who in the early 1930s developed the diagnostic techniques of plant tissue analysis, had a tremendous impact on French overseas agriculture research. Much of the credit for the development and use of tissue testing as a means of control of the nutrient status of tropical crops must go to the French researchers. The French tissue testing work has received international acceptance, and the close working link between the Malaysia oil palm and rubber industry agronomists and their French colleagues is an example of this acceptance.

The major aim of tissue analysis is to establish norms for a healthy plant growing under good conditions. Norms have been established for N, P, K, Mg, Ca for the tree crops, for bananas, and for coffee and cotton. This information, in combination with soil analytical data and the level of nutrient exported from the field with the harvested portion of the crop grown, has led to fertilizer recommendations that must be essentially correct for the conditions in Cameroon, although many officials question the type of fertilizer recommended for coffee production over a wide range of soils.

Three problems could perhaps be noted: (1) the apparent slowness in changing over from the expensive ammonium sulfate (AS) to the cheaper urea, (2) the lack of monitoring of the economic returns from fertilizer use, and (3) the need for better communications with farmers and the crop production specialists of IRA. These problems reflect a lack of responsiveness of the system, not a lack of technical competence.

For food crops, although only the fertilizer response of monoculture rice has been well documented in the past, the response curves of pure stands of maize, groundnuts, and sorghum--major food crops--are now becoming available.

Apart from the work of the FAO Fertilizer Programme, terminated in 1972, fertilizer response data for the complex cropping systems of the coffee areas are lacking, and the transfer of responses obtained with pure stands of any particular crop to the mixed cropping system is fraught with danger. One thing is, however, abundantly clear and that is that 20-10-10 and ammonium sulfate coffee fertilizers are used by default as food-crop fertilizers. The need for a high phosphate basal fertilizer dressing such as a 10-30-10 followed by topdressings of urea, as and when necessary, is widely recognized. Such a fertilizer combination would be of great value to the intercropped groundnut/maize system. A basal dressing of 10-30-10 would be adequate for the groundnuts or beans and would act as an excellent starter for the maize crop to be followed by topdressed urea on the maize only at a later stage.

Such an approach presupposes a change to line sowing rather than the traditional mound sowing. Such changes can occur very quickly where farmers have an economic incentive to change their practices.

Oil Palm and Rubber

Industrial estates of oil palm and rubber monitor soil and plant tissue levels and correct fertilization as necessary.

Fertilizers used are ground phosphate rock (now being replaced by diammonium phosphate [DAP]), sulfate of ammonia (now being replaced by urea), potassium chloride (KCl), kieserite to correct magnesium deficiency, and crushed dolomite to correct calcium and magnesium deficiencies and soil acidity.

The major fertilizer-related problem facing these estate organizations is the heavy cost of fertilizer application and the danger of excessive loss of nitrogen from surface-applied urea and DAP. The possibility of using liquids for application should be considered because this could reduce application costs and could reduce losses of ammonia from urea and DAP. (See Table I-6 for the estimated use of fertilizer on these crops.)

Banana

Up to the present, fertilizer recommendations for bananas were 1,400 kg of AS and 100 kg of KCl per cycle with 2,000 plants to the hectare.

OCB was not satisfied with the growth of some of its plots and requested a survey of its banana plantations in April 1984; this was carried out by the IRA Ekona Station. The problem was identified as excessive acidity caused mainly by the heavy dressings of ammonium sulfate. Dolomite treatments have now been started, and the IRA Station at Nyombe has been given the task of monitoring soil and plant tissue nutrient levels in order to avoid waste of potash and prevent excessive soil acidification. All bananas for export are well fertilized. IFDC estimates indicate that 2,000 mt of fertilizer was used on this crop.

Pineapple

The amount of fertilizer use is quite high, 300 kg of nitrogen as urea and 600 kg of K_2O as potassium sulfate per hectare per year. Although nitrogen increases yields and potash does not, apparently these heavy doses of potash are needed to maintain quality at the higher yields which nitrogen gives.

The pineapples are fertilized using dilute solutions sprayed onto the crop at regular intervals in the dry season and solids applied into the axils of the older leaves in the wet season.

Without fertilizer use, export-quality pineapples cannot be grown, and therefore all export pineapples are well fertilized.

Sugarcane

The first plantation established, SOSUCAM, has a total area of 6,960 ha, of which 5,500 ha of cane is harvested each year.

The cropping system is plant-cane followed by 8-10 ratoon crops and then a leguminous fallow of 1-2 years before replanting. The fields are burned before harvest and hand cut. Yields are 64 mt/ha of cane with a rendement (factory recovered sugar) of 9%. The crushing season is 6 months, from March to September.

The factory residues, scums (0.4% N, 0.8% P_2O_5), and molasses (4.5% K_2O) are used together with fertilizers.

At planting, 20 mt of scums and 3 mt of molasses are used. For the ratoons the following amounts are used: 200 kg of urea applied in split doses (100 kg on the surface of the harvested field and 100 kg applied by air after 3 months), 50 kg DAP applied on the surface after harvest, and 250 kg KCl applied on the surface after harvest. Two mt of molasses is also applied on the surface after harvest.

In the past ammonium sulfate was used, but because the soils are naturally acid, problems due to an increase of acidity have apparently arisen.

The company is now starting a program of applying 2 mt/ha of ground limestone each 10 years. The limestone is obtained from the northern deposit at Figuil. The material is 49% CaO and only 0.5% MgO. It is rather coarsely ground (100% through 1 mm and 50% through 0.1 mm sieves).

The estate has its own agronomy section and apparently continues to carry out agronomic and soil fertility research.

The second sugar plantation, CAMSUCO, created in 1974 is contiguous with SOSUCAM; apparently the two plantations are very competitive, at least in terms of agronomic and soil fertility research. The total area at CAMSUCO is 12,000 ha, the developed area is 11,300 ha, and the planted area is 10,900 ha. Yields are slightly over 84 mt/ha and the rendement is 8.25%. There are rather large areas of termite-affected land, and the molasses and scums are used entirely on these areas in order to increase soil fertility and organic matter.

Plant cane is fertilized in the furrow at planting, and the ratoons are fertilized after harvest. Average treatments are urea at 80 kg N/ha, DAP at 28 kg N/ha + 70 kg P_2O_5, and KCl at 180 kg K_2O/ha. Urea is not split dressed as at SOSUCAM. Limestone is not used because soil pH is above 5.5.

The probability of up to 20% loss of nitrogen from the surface-applied urea and DAP by ammonia volatilization was accepted by both estates.

Fertilizers for the sugar industry are not subsidized and so presumably are used judiciously. All technical information on yield trials was regarded as confidential at both estates, but it was stated that at least 25% of the total yield of sugar was credited to fertilizer use.

Cocoa

This major cash crop of the small farmer is not usually fertilized. Correct management alone can improve yields considerably.

Coffee

The following are the recommended fertilizer treatments.

Arabica (average yield, 165 kg/ha; 700 kg/ha good)

1.	Volcanic soils	200 kg AS/ha
2.	Ferallitic soils	200 kg 20-10-10/ha
3.	Leached ferruginous soils	200 AS or 20-10-10 + 200 kg KCl/ha

Robusta (average yield, 400 kg/ha; 1,200 kg/ha good)

1.	Volcanic soils	400-800 kg AS/ha
2.	Ferallitic soils	400-800 kg 20-10-10/ha
3.	Leached ferruginous	400-800 kg 20-10-10 + 200 kg KCl/ha

The material is sprinkled in a circle around the edge of the bush in March and in September. It may be lightly worked into the soil.

Because of the acidifying effect of AS and the availability of cheap urea, AS will be replaced by urea.

Fertilizer pays on well-maintained coffee; however, because currently all coffee fertilizers are heavily subsidized, little interest in the true economics of fertilizer use has been evinced. Coffee growers account for almost 50% of the fertilizer used in Cameroon; however, some of this fertilizer is used on food crops.

Rice

Rice is a traditional crop in Cameroon. Additionally, government programs using modern technology have been developed over the years.

The two major rice-growing areas are in the west and in the north--the latter being the major paddy production area. Yields in the traditional sector are about 1.5 mt/ha, whereas the modern irrigated sector averages around 5 mt/ha; 19,000 ha of rice was planted in 1984.

As with many government-sponsored schemes, mere physical production of a crop is found to be only a part of the total picture. World Bank comments on these government-sponsored rice projects are essentially negative because the rice that has been produced, in contrast with traditional cereals, has not proven to be economically competitive with imports. Because of the large financial investment made by government to date in land preparation and infrastructure, little or no further expansion of domestic rice production other than by increasing the productivity of the existing areas will be contemplated.

Experience in Asia shows clearly that modern rice varieties respond to fertilizer use, particularly when grown with good water control and under high incident solar radiation. Double cropping can increase annual yields per hectare and thereby maximize returns on investments in irrigation facilities. These conditions can probably be met in the North and Extreme North Provinces, but low incident radiation and low temperatures are constraints in the West and North West Provinces. Low temperatures are possibly also a constraint in the north in the dry season.

Standard rice fertilizers are AS, 20-10-10, urea, DAP, triple superphosphate (TSP), and KCl. With the heavy transport costs, urea (46% N), DAP (18% N, 46% P_2O_5), and KCl (60% K_2O) are the fertilizers of choice.

The current fertilizer recommendations for rice are as follows:

Province	Organization	
North and Extreme North	SEMRY--irrigated	90 kg N as urea split into three applications. Where S deficiency occurs, the first application should be AS.
	SODECOTON area--rainfed	+23 kg N as urea 30 days after germination. For higher yielding fields (up to 3 mt/ha) 100 kg 20-10-15 + 23 kg N as urea before planting + 23 kg N as urea 30 days after germination.
North West and West	Irrigated	80 kg N plus 60 kg P_2O_5. In practice various rates of urea, AS, and 20-10-10 are used.

All irrigated rice is fertilized. Most rainfed rice is not fertilized. A major technical failing of flooded rice fertilization is the large loss of nitrogen caused by decomposition of fertilizer urea in the floodwater and consequent losses. Application of the urea to newly drained paddies followed by reflooding can reduce these losses. Fertilizers for rice are subsidized.

Food Crops

In those ecological zones where research work on food crops has been continuing effectively for some time, fertilizer treatments, which are just now being taken up by the extension service, have been recommended.

For the West and North West Provinces for mixed crop areas these recommendations are as follows:

1. On ferrallitic soils not covered by ash--60-50-0 (60 kg N, 50 kg P_2O_5, 0 kg K_2O/ha).
2. On ferrallitic soils covered with ash--60-100-0 (60 kg N, 100 kg P_2O_5, 0 kg K_2O/ha).
3. On the brown and black soils--60-0-0 (60 kg N, 0 kg P_2O_5, 0 kg K_2O/ha).

These recommendations apparently give a yield increase worth 23,000-35,000 FCFA/ha.

In the North and Extreme North Provinces, where maize or sorghum is grown in rotation with cotton, it is recommended that these cereal crops receive

50 kg/ha of urea 30 days after planting. This treatment, which gives 300-1,000 kg/ha of additional grain, is possible because the cereal crop benefits from the residual effects of the cotton fertilizer--mainly the phosphate component--and therefore can respond well to just a supplementary nitrogen fertilizer application.

For groundnut in the northern provinces, 100 kg of TSP/ha is recommended. Of the fertilizer used in Cameroon, 15% goes on food crops (Table I-66), particularly on maize in the North West and West Provinces and on irrigated rice.

Cotton

Cotton is grown in the two northern provinces under the aegis of SODECOTON. This cotton monopoly controls the cotton gins and has therefore established a well-functioning crop lien system with the small farmers of the cotton area.

Fertilizer recommendations are based on the experience and the support of researchers responsible for cotton growing across the whole zone from Senegal through the Ivory Coast, Burkina Faso, Mali, Chad and, of course, Cameroon. The national cotton research center of IRA at Maroua refines these recommendations to the local conditions.

The basic fertilizer treatments recommended are 200 kg/ha 15-15-15-6S-1B at planting plus 50 kg/ha urea 30 days after planting. The basic formula is varied according to various climatic zones and soil conditions. North of the 700-mm isohyet no supplementary urea is used. In the south, where rainfall is good and the production standards of the farmer are good (yields of more than 2 mt of seed cotton are common), the recommendation is for up to 300 kg/ha of 15-15-15-6S-1B as a basal dressing and 50 kg urea as a topdressing at 30 days after planting.

Recently, SODECOTON has imported 22-10-15-5S-1B which is recommended at 200 kg/ha in the Extreme North Province. This change was made to ensure early application of a higher level of nitrogen. The need for sulfur and boron has been adequately demonstrated.

SODECOTON ensures that fertilizer recommendations are carefully followed by all cotton growers. Fifty percent of the yield of seed cotton is credited to fertilizer use.

The foregoing description is based on general information only. Actual field practices vary from the use of no fertilizer at all up to state-of-the-art fertilizer treatments. Section I, Part II illustrates with actual field data the farm-level fertilizer practices.

Selection of Fertilizers--Agronomic and Economic Factors

Fertilizer should be purchased only on the basis of cost effectiveness. However, product quality, i.e., granules instead of powder, and convenience, i.e., multinutrient versus straight fertilizers, play a role in the choice. Of course, convenience carries with it a price premium which may or may not be compensated for in terms of crop production economics.

Low-analysis fertilizers are more expensive to bag, distribute, and store than are the equivalent nutrients in concentrated fertilizers, and therefore, the international trend has been toward the use of high-analysis fertilizers.

Three factors which affect the final cost of fertilizer applied in the field must be examined:

1. The technology of production.
2. Handling, distribution, and storage.
3. Choice of nutrient carrier.

Technology of Production

Until large fertilizer markets have been built up, production units with a low level of capital investment and a flexible operation should be the prime objective. This point is fully discussed in Section III.

Handling, Distribution, and Storage

Efficient handling, distribution, and storage of fertilizers are essential if costs are to be kept as low as possible. With the tremendous distances and generally poor hinterland infrastructure, Cameroon faces enormous problems. Inefficient logistics not only increase fertilizer costs but can also reduce the efficiency of its use; fertilizer which arrives late or not at all, or which is of the wrong kind, can reduce anticipated crop yields and destroy the carefully nurtured confidence of the farmer in relying on input supplies.

Costs associated with fertilizer handling, distribution, and storage are very high. For example, the f.o.b. cost of ammonium sulfate is doubled by the time the fertilizer reaches the farmer.

The doubling of the f.o.b. cost per sack of fertilizer delivered to the Cameroon farmer means that only products with a high content of nutrients can be considered. The following questions must be answered:

1. What nutrients are needed?
2. What is the least cost delivered form of these nutrients?

The major plant nutrients used in Cameroon are in order of tonnages:

1. Nitrogen.
2. Potash.
3. Phosphate.
4. Sulfur.
5. Magnesium.
6. The trace elements boron, zinc, etc.

Table I-5 gives the composition of the major internationally traded fertilizers.

The first point to be made from the table is that if sulfur is a required nutrient item, ammonium sulfate can be considered as a high-analysis fertilizer. If, however, sulfur is not a needed item, it is a low-analysis fertilizer which cannot compete in terms of delivered cost with urea. Full details of f.o.b., c.i.f., and delivered fertilizer prices are given in Section II. However, the delivered cost of nitrogen in AS is twice that of the cost of N in urea.

Phosphate rock, single superphosphate (SSP), and triple superphosphate also contain calcium which may be needed as a plant nutrient; however, where calcium is low, the use of small dressings of local limestone would appear to be the most logical way to correct this problem.

Selection of Nutrient Carrier--Nitrogen and Urea

Although ammonium sulfate and ammonium nitrate (AN) are effective fertilizers, they are being replaced in world trade by urea because of its delivered cost advantage.

Diamond (1983) has reviewed the agronomic appropriateness of urea as a fertilizer in West Africa (Nigeria) and the general facts presented apply also to Cameroon. They are discussed under the following headings.

Toxicity--The toxicity of free ammonia, formed by the hydrolysis of urea in soil, is a potential crop hazard following improper use of urea. In most warm, moist soils urea hydrolysis is rapid. Ayanaba and Kang (1976) found that urea hydrolyzed within 1 week in three Nigerian soils. This rapid hydrolysis can give rise to high concentrations of free ammonia near the urea placement sites. Because of the toxicity of free ammonia to plants, it is recommended that urea never be placed in close contact with seeds or in contact with the base of young plants.

Table I-5. Major Internationally Traded Fertilizers

Product	% by Weight			Total Nutrient Content, %	
	N	P_2O_5	K_2O	$N + P_2O_5 + K_2O$	S
Ammonium chloride	26	-	-	26	-
Ammonium nitrate	34	-	-	34	-
Ammonium sulfate	21	-	-	21	24
Urea	46	-	-	46	-
Monoammonium phosphate	11	52	-	63	-
Diammonium phosphate	18	46	-	64	-
Phosphate rock	-	30-34	-	30-34	-
Potassium chloride	-	-	60	60	-
Potassium sulfate	-	-	50	50	18
20-10-10	20	10	10	40	-
15-15-15	15	15	15	45	-
20-20-0	20	20	-	40	-
SSP	-	20	-	20	12
TSP	-	46	-	46	-
16-20-0	16	20	-	36	9-13 Depending upon process

Source: IFDC. 1985.

N Loss--Ammonia volatilization loss is another potential limitation on the use of urea. When urea is incorporated into soil, the free ammonia formed upon hydrolysis ionizes with water and the ammonium ion is held by the cation exchange complex of soil. Volk (1966) reported that up to 80% of urea on a dry soil surface remained as urea for 14 days under high humidity and nightly dews. However, when urea is left on a moist soil surface, especially with an upward flow of water, hydrolysis to ammonia is rapid, and a portion of the free ammonia escapes to the atmosphere. Rainfall in sufficient quantity to move the urea into the soil would minimize this ammonia volatilization loss, whereas very light rainfall, just sufficient for hydrolysis of urea, followed by drying conditions would cause large ammonia volatilization losses. The varying rainfall patterns following urea application are some of the reasons for erratic results reported for the relative efficiency of urea, especially when surface applications have been used.

A brief summary of findings of many trials indicated that when urea was incorporated into the soil within 1 day following application, either through water additions or tillage, it was as effective as AS or AN as a source of nitrogen. When broadcast and left on the soil surface, the average of many trials for upland crops and paddy rice showed that urea was slightly inferior to AS or AN; however, urea was significantly inferior in some trials. In the latter cases the poor performance was generally attributed to ammonia losses. Empirical research data confirm the high potential losses of ammonia from surface applications of urea from both upland soils and water surfaces of paddies. Where pH is greater than 7.5, ammonia losses may also occur from surface-applied ammonium sulfate.

Effects of Nitrogen Fertilization on Soil Properties--A major concern of many agriculturists is the acidification of tropical soils where crop intensification and increasing use of nitrogen are occurring. The acidifying effect of nitrogen fertilizers is of greater consequence in sandy soils of low cation exchange capacity (CEC) than in soils of higher CEC, and therefore soil acidification is potentially a serious problem on many soils in Cameroon.

Nitrification of ammonium forms of fertilizer (change from ammonium to nitrate) produces hydrogen ions which can contribute to soil acidity. Each kilogram of nitrogen potentially requires 1.8 kg of calcium carbonate to neutralize the acidity. Furthermore, the associated anions of ammonium fertilizers give rise to additional acidity due to residual anions. Potential acidity from

several nitrogen fertilizers is shown in Table I-6. Ammonium chloride and AS are the most acidic because of the contribution of sulfate and chloride to potential acidity. Products such as calcium, potassium, and sodium nitrate have positive liming values because of their basic cations.

In actual practice these potential values are not observed in soils. Volatilization losses either by denitrification or as ammonia result in a decrease in potential acidity. Adsorption by plants modifies acidity to the extent that cations or anions are preferentially taken up by plants. The final acidity from a fertilizer in a particular zone of soil develops only after residual salts are removed from that zone by leaching.

Research has confirmed that:

1. Continuous use of N fertilizers (particularly at high rates) decreases soil pH of sandy soils which have low buffering capacities.
2. The lower pH is caused by lowering of calcium and magnesium status of soils and is accompanied by an increase in extractable aluminum and sometimes manganese.
3. AS has a greater depressant effect upon soil pH than does urea or calcium ammonium nitrate (CAN). The latter two sources of N result in similar effects on soil pH, even though theoretically urea has the greater potential acidity.

Limited research indicates that on the sandy soils:

1. Calcium status may be so critical that even low amounts of added calcium may be important in maintaining suitable calcium levels in soils.
2. Excessive potassium applications may critically alter the potassium: magnesium ratio causing magnesium deficiency.

Agronomic Issues Relevant to Urea Use in Cameroon--Urea rapidly hydrolyzes in most soils and, depending on the pH, free ammonia may be lost to the atmosphere. Sandy soils of low buffering capacity and drying atmospheric conditions will accentuate any losses of ammonia.

Free ammonia is toxic to growing plants, especially young seedlings. Placement of ammonia-forming fertilizers near plant roots can kill or severely stunt plant growth. Limited soil moisture and low buffering capacity increase the likelihood of crop damage. Until research indicates otherwise, urea should be incorporated into the soil the same day of application. For most crops one-third to one-half of the nitrogen should be broadcast prior to planting and

Table I-6. Potential Acidity of Nitrogen Fertilizers

Fertilizer	N (%)	Potential Acidity[a] kg $CaCO_3$/ kg Fertilizer	Potential Acidity[a] kg $CaCO_3$/kg N
Anhydrous ammonia	82	1.48	1.8
Urea	46	0.84	1.8
Ammonium nitrate	33.5	0.59	1.8
Ammonium sulfate	21	1.10	5.2
Ammonium chloride	25	1.28	5.1
Ammonium nitrate limestone[b]	20.5	0	0
Calcium nitrate	15	-0.20	-1.3
Sodium nitrate	16	-0.29	-1.8

a. Amount of pure $CaCO_3$ required to neutralize acidity produced by fertilizer in soil.

b. Other similar products are calcium ammonium nitrate, nitro-lime, and nitro-chalk. Various means of production result in variations in grade and potential acidity.

Source: IFDC.

incorporated. The remaining urea should either be sidedressed or placed about 10 cm from plants. In any case, it must be incorporated into or covered with soil. Widespread extension activities will be needed to guide farmers in the proper use of urea. Where urea cannot be incorporated into the soil, split applications will reduce the risk of heavy losses of ammonia; alternatively, urea solutions could be used.

Combining urea with compounds that give an immediate acid reaction in soils (monoammonium phosphate) may have a slight effect by reducing ammonia volatilization losses; in general, however, compound fertilizers containing urea should be applied in a manner similar to that for straight urea.

With the ever-increasing soil acidity problem, some means of applying calcium carbonate to soils must be developed. Ground limestone possibly could be cogranulated with urea, but it would likely be less expensive to develop an agricultural limestone industry to supply liming materials. Cameroon has such a potential industry because it has deposits of limestone that are of industrial size; these deposits are currently being either exploited (Figuil) or studied (north of Douala).

Selection of Nutrient Carrier--Phosphate

Internationally traded phosphate fertilizers are ground phosphate rock, monoammonium phosphate (MAP), DAP, the whole range of NPK materials, TSP, SSP, and ammonium phosphate sulfate. These materials are described in Table I-5.

Results of research on soil and fertilizer phosphate are legion, and if Cameroon had been fortunate enough to have exploitable deposits of phosphate rock, as do Niger, Mali, Burkina Faso, and, particularly, Togo and Senegal, then an in-depth discussion of the most effective form of phosphate would have been needed. As it is, Cameroon must import all of its phosphate needs; under these conditions the economic argument for high-analysis material, as was the case with nitrogen, outweighs the opportunity for some flexibility in the selection of imported phosphate products.

Ground phosphate rock has been widely used on commercial plantations in the past, but its high costs have led to its replacement by DAP. The loss of the calcium component of phosphate rock when the change to DAP is made, is being compensated for by the use of imported dolomitic limestone. Limestone from the northern deposit at Figuil is being used by the sugar plantations.

The following generalizations on phosphate selection illustrate the results of recent research.

1. Both water-soluble fertilizers and citrate-soluble P fertilizers may be said to be available to plants, but there can be considerable differences in crop response under different circumstances.
2. For absolute maximum yields, regardless of soil or annual food crop to be grown, highly soluble P sources are the fertilizers of first choice. For crops grown under the typical constraints of developing countries, water solubility is less important.
3. Citrate-soluble phosphates low in water-soluble P and unacidulated phosphate rock with a high chemical reactivity may be as effective as water-soluble sources on long-season crops.
4. Phosphate rock is generally most effective on soils with low P-retention capacity.
5. In cases where P demand of the crop exceeds the capability of an unacidulated source to supply P or where the P-retention (fixation) capacity is so great that the rock is incapable of raising the concentration of P in soil solution to an adequate level, sources with 50% or less of the total P in water-soluble form have generally been found to be essentially equal in effectiveness to the completely soluble forms.
6. Short-season, fast-growing crops and those with restricted root systems generally require a fertilizer containing a high proportion (50%-60%) of water-soluble phosphate for maximum yields. Such crops frequently give only limited response to applications of citrate-soluble materials. This is primarily true for soils that are low to medium in available P.
7. When little phosphate is to be applied, the greatest crop response and most efficient use of P will be achieved by band application adjacent to the seed or transplant. In such cases 50%-60% of the P should be in the water-soluble form.
8. Water solubility increases in importance where soil moisture is limiting.
9. With phosphates of high water solubility, effectiveness increases with an increase in particle size.
10. For row or band application highly water-soluble sources of P combined with ammonium-N are most useful.

In general, when the degree of water solubility of the P and the granule size of fertilizers are comparable, there will be little difference in the availability of the fertilizers, regardless of the method of manufacture.

Value of Residual Phosphate--One of the economic factors influencing phosphate use deals with residual phosphate. Most economic analyses as well as government policies fail to put a value on residual phosphate. As a result, much confusion prevails on this subject, which in turn affects phosphate use. Farmers treat phosphate as an annual cost and apply it accordingly. However, only 5%-15% of the fertilizer P applied to the soil is recovered by the first crop. Unlike nitrogen or sulfur, the remaining phosphate is held in the soil and is added to a phosphate pool which is gradually available to subsequent crops. As a result, annual additions in excess of crop removal will gradually build phosphate fertility in the soil. The speed with which this fertility is built will depend on a host of factors including the rate of P_2O_5 application in relation to removal and the P-retention characteristics of the soil.

Selection of Nutrient Carrier--Potash, Sulfur, Magnesium, Trace Elements

Potash--Potassium chloride is the standard potash fertilizer. It is 60% K_2O and is thus considered a concentrated source of potash. Because of the low cost of production, potassium is the cheapest nutrient, and it is simple to use.

Sulfur--Recent experience in West Africa and in Cameroon has shown sulfur deficiency to be more widespread than was thought. Poor crop residue management and the use of sulfur-free fertilizers will aggravate the situation.

Accurate diagnosis is the key to the removal of yield limitations due to sulfur deficiency. For many of the crops of importance to Cameroon, diagnostic criteria are nonexistent or lacking in precision.

Sulfur is recommended for cotton in Cameroon, but for other areas and crops potential sulfur deficiency has probably been masked by the use of ammonium sulfate.

The change to more concentrated fertilizer, and particularly from ammonium sulfate to urea, is a cause of concern. Researchers should carefully examine the possibility that at least a modicum of sulfur is needed in all compound fertilizer formulations in order to prevent loss of yield should sulfur in fact be limiting. Ammonium sulfate and 16-20-0 are good sources of sulfur.

Magnesium--This element is generally low in Cameroon soils, but this is not a cause for concern unless high levels of potash are used, which can induce deficiency of magnesium.

The ideal source of magnesium for Cameroon is dolomite, which is imported by some plantations; some kieserite, a more expensive source of magnesium, is also imported.

Trace Elements--There is a wide range of products available as salts, oxides, or chelates. Trace elements are required in such small quantities that they may present a problem to the bulk-blend fertilizer formulator. The major word of caution is that at high levels some can be toxic to plants. Boron, particularly, can accumulate quite quickly to toxic levels.

Mixed Fertilizers

Crops need many nutrient elements for optimum growth, but fertilizers containing nitrogen, phosphorus, and potassium account for almost all the world's supply. However, sulfur is becoming increasingly important in Cameroon and supplementary magnesium is used on many plantation crops so that significant tonnage of fertilizers containing these two nutrients is used. Local deficiencies of trace elements also occur. Total tonnages of trace elements used are, however, relatively small.

Persuading the farmer to use the correct rate and type of fertilizer nutrients on his crops is a problem that exercises the minds and resources of the governments of many developing countries.

The problem of balanced fertilization is two-sided: many fertilizer recommendations made in developing countries are not site specific and are based on experiment station trials, which often give much higher yields than the average farmer can achieve; conversely, many farmers do not fertilize in an optimum way even for their lower yields.

When fertilizer recommendations and actual farmer use practices do not match, it is essential that the research agronomists, the fertilizer marketer, the extension staff, and the farmers be involved in identifying the reasons for the disparity and in developing corrective measures.

Cash and inputs credit programs that give the farmer a package of desirable practices, including specified quantities and types of fertilizer, ensure that the farmer at least acquires the officially recommended fertilizer. Such package credit programs have been widely used with success in Africa by the crop monopoly organizations.

In India control orders require fertilizer retailers to stock both phosphate and potash at a specified level in relation to their sales of nitrogen.

With a free market situation, it is necessary to educate the farmer to maximize his returns by using the correct rates and ratios of fertilizer nutrient.

When all the nutrients to be used in an agricultural area come together at one point, whether it is port, railhead, or road, then the need for and desirability of producing NPK fertilizers at that point must be examined. A case can be made for any one of the following three alternatives for the Cameroon situation:

1. Continuing to move products as separate and distinct materials.
2. Mixing the incoming nutrients using current bulk-blending technology.
3. Processing the incoming nutrients to make granular complex fertilizers.

The final choice of technology will depend on the local situation. Cameroon has had the misfortune to have invested in a granulation plant at the wrong time in its fertilizer use development. Low sales and high production costs led to early closing of the plant.

With a typical small farm of 1-2 ha and individual plots of about ¼ ha, the farmer using hand spreading will have all the flexibility he needs for varying fertilizer dressing by field, by crop, and by season, even though he purchases straight fertilizers.

Bulk blending is attractive as an alternative to handling straight N, P_2O_5, and K_2O through the distribution system, but the risk exists that the nutrient ratios delivered to the system will be overtailored. Only a few major grades should be made, and even then, in practice farmers will probably find themselves being forced to take grades not totally adequate for their need because of deficiencies in the marketing system.

Granular fertilizers have achieved great popularity among the small farmers of Africa because of the reliability of the products. Blue, green, or red high-quality fertilizer granules cannot be counterfeited by backyard operators; this fact, together with the strong sales pitch that "every granule contains the same nutrients as every other granule," has certainly attracted a loyal clientele for the producers of granular fertilizers. Complex fertilizers continue to be of great interest for upland crop production to the high-value cash crop grower, and they are favored by cotton development schemes in Africa particularly.

In the final analysis, hand application of the cheapest solid materials such as urea, DAP, and KCl is probably the most economic route, but it is also the one which relies most heavily on the farmer's knowledge of the nutrients needed. Therefore, the relevance of the next lowest cost solution, that of bulk blending, must be evaluated.

There is a general trend toward manufacturing concentrated fertilizers in large plants at or near the source of the raw materials and shipping the products in bulk to consuming areas. This trend is likely to continue. Bulk shipment of finished products requires reasonably free-flowing materials so that products such as urea, diammonium phosphate, and potash (KCl) can be loaded and unloaded from ships, barges, and railcars rapidly. Therefore, these materials will likely be produced in granular form to avoid serious caking. The availability on the world market of an abundance of these high-analysis, reasonably priced materials will encourage bulk blending because blending adds very little to the cost of bulk shipment, storage, handling, bagging, and distribution. Although blending has long been popular in the United States and Canada, there appears to be a growing trend for the practice to spread to other countries. There is much interest in this approach in West Africa.

Although bulk blending is a simple process, there are elements of technology that should not be ignored. Production of satisfactory blends in developing countries requires more care than in cooler, less humid climates. Unlike the common practice in the United States of mixing and applying blends on the same day, in most countries the blends must be bagged, stored, and transported through the distribution system to the farmer. Thus, the blends must have good physical properties, and the bags must have adequate strength and resistance to moisture penetration if they are to reach the farmer in usable condition.

Some developing countries have a tendency to neglect the quality of both straight and mixed fertilizers and their packaging when better technology would be appropriate to the climatic conditions and the available distribution facilities. It is unfortunate that many countries appear willing to spend huge sums of money on manufacturing facilities but fail to provide adequate facilities to ensure that products are of good quality and can be delivered to farmers in usable condition.

The technical aspects of bulk blending are discussed in detail in Section III.

Selection of Most Appropriate Fertilizers--Conclusion

The choice of fertilizer for sale to farmers should be made on the basis of cost per unit of agronomically effective nutrient applied in the field.

Urea is extremely competitive with other forms of nitrogen. In Cameroon, where transport and distribution costs are high, the high analysis of urea (46% N) makes it the rational choice.

For phosphates the materials DAP and MAP are currently extremely competitive in Cameroon, again particularly because their high analysis reduces transport and distribution cost. Rock phosphate, which is the cheapest phosphate source f.o.b. West Africa, is not competitive with DAP when evaluated at delivered price at the farm. Large-scale soil rehabilitation projects in southern Cameroon should consider bulk rock phosphate as a P source; under these conditions it would then be competitive because it would be much cheaper delivered in the field than would bagged phosphate rock.

Potassium chloride as the material of choice is the cheapest, most effective potash fertilizer.

The following fertilizers are the principal fertilizers used in Cameroon:

Subsidized	20-10-10	(Coffee and food crops)
Subsidized	Ammonium sulfate (21-0-0)	(Coffee and food crops)
Subsidized	Urea (46-0-0)	(Coffee, food crops, and rice)
Nonsubsidized	22-10-15-6S-1B	(Cotton)
Nonsubsidized	15-15-15-6S-1B	(Cotton)
Nonsubsidized	15-20-15-6S-1B	(Cotton)
Nonsubsidized	12-6-20[a]	(Banana)
Nonsubsidized	Urea (46-0-0)	Industrial sector
Nonsubsidized	DAP (18-46-0)	Industrial sector
Nonsubsidized	KCl (0-0-60)	Industrial sector
Nonsubsidized	Kieserite (Mg)	Industrial sector
Nonsubsidized	Limestone (Ca) and dolomitic limestone (Ca and Mg)	Industrial sector

a. Some subsidized 12-6-20 is sold around Douala and Yaounde for use on plantains and local bananas. From 1984/85 West Province has ordered major tonnages of subsidized 12-6-20 for use on coffee and food crops.

Source: IFDC Survey, 1985.

The major type of fertilizer missing from this list is that of a high-phosphate starter fertilizer for maize and the other food crops, mainly the leguminous types. DAP could be the fertilizer of choice, but sulfur deficiency is being increasingly recognized as a constraint to crop production in Cameroon; traditionally, also, small amounts of potash have been included in all multinutrient fertilizers.

It is proposed that, taking into account the varied soils and crop growth conditions in Cameroon, an acceptable and marketable fertilizer would have a composition of approximately 10-30-10-5S. The actual composition should be decided by the national research cadre and would represent a compromise based on the value of the fertilizer over the widest range of conditions. Such a fertilizer would provide excellent crop establishment for a wide range of soil and crops and would be a good total fertilizer for soybeans, groundnuts, etc. For maize and other cereals, urea would then be used as a nitrogen supplement.

Where severe deficiencies of potash or sulfur are identified, additional treatments of straight muriate of potash and ammonium sulfate can be used. If the area so treated became large enough, grades could be changed quite simply. However, once again the warning must be given that an excess of grades for use by small farmers will be self-defeating in the long run.

Fertilizers used in Cameroon should be selected only following in-depth discussions between research and extension. Intensive farmer education programs should follow any change of fertilizer made available to farmers because it is essential that farmers fully understand the most effective means of using the fertilizers available. The use of agricultural liming materials must be encouraged in areas with extremely acid soils and aluminum toxicity.

Crop Responses to Fertilizers in Cameroon--
Physical Crop Response Data

The two major cropping systems in which fertilizer is used by the small farmer in Cameroon are the coffee-food crops systems in the densely populated parts of the North West and West Provinces and the cotton-cereal system in the North and Extreme North Provinces. These two systems are extremes in many ways, not only from the point of view of agroecological zones but also from the point of view of marketing infrastructure.

The coffee farmer has available the services of cooperatives, and all fertilizer, which is subsidized, is handled by these agencies. Farmers may or may not sell their coffee through the cooperative and can purchase the fertilizer from the cooperative for cash at the subsidized price without being members.

The cotton farmer is under the tutelage of SODECOTON, which provides all inputs on a cotton crop lien basis. Cotton fertilizers are unsubsidized but are sold by SODECOTON at less than actual costs. For cotton growers food crops are included in the package of recommended practices delivered by the extension service. Both groups of farmers, the coffee growers and the cotton growers, are similar in that the food crops they grow benefit from the fertilizer used on their respective cash crop, and moreover, both increasingly use fertilizer specifically for food-crop production particularly for maize and to some extent in the north for sorghum also.

The fertilizer recommendations for coffee were based on coffee as a sole crop, and the fertilizers used were never intended to become major food-crop fertilizers. The soils in Cameroon are acid and generally deficient in phosphate. Although ammonium sulfate and 20-10-10 are suitable fertilizers for coffee, which is a perennial crop, they are not suitable for food crops. As discussed earlier, ammonium sulfate tends to acidify the soil and 20-10-10 lacks the concentration of phosphate needed for annual food crops, especially for legumes grown in association with maize.

The cotton farmer is more scientifically guided; he uses the residual effects of his cotton fertilizer and dressings of supplementary nitrogen as urea, for good and profitable yield increases of the cereal in rotation with cotton. Particularly the phosphate component of cotton fertilizer was recognized early as giving good response in the cereal crop following the cotton.

Work on the role and value of fertilizers in some of the complex cropping systems that exist has only recently become a major activity. The work of the FAO Fertilizer Programme during the period 1968-73 concentrated on the value of fertilizer to the small farmer but worked essentially on pure stands of individual crops.

The FAO Fertilizer Programme included both factorial trials and non-replicated dispersed demonstration trials in farmers' fields. Since only a limited number of fertilizer treatments was tested, no nutrient response curves could be developed and optimum rates of application could not be calculated. However, the value/cost (V/C) ratios[1] and net benefits which were established for all the treatments that were used showed that over a wide range of crops and soils, low rates of fertilizer use under small farmer conditions were generally profitable.

---

1. The value of the increase in crop yield attributable to fertilizer divided by the cost of that fertilizer.

Research results on the effects of fertilizers on the yields of the grain crops maize, sorghum, and rice come also from work in pure stands.

Coffee

Three major soil types occur in the coffee-growing area: (1) recent volcanic soils, which usually have well-balanced and adequate base saturation and require only nitrogen for maximum yields; (2) ferrallitic soils (French) or Ultisols and Alfisols (United States), which are the most widespread, are characterized by leached parent material, low pH, low CEC, and generally low phosphorus status, and for which 20-10-10 is recommended; and (3) very desaturated ferrallitic soils or Ultisols, which have a high potassium requirement for optimum crop response to N fertilizer, and for which 20-10-10 and supplementary KCl are recommended.

Research on coffee has been continual, and fertilizer response information has been developed for N, P, and K at different locations on the most representative soils under this crop. Because coffee fertilizer was subsidized and AS was sold at the same price as 20-10-10, interest in refining fertilizer recommendations was low in the past. However, because coffee prices have tended to fall and fertilizers have tended to be in short supply, IRA is reexamining fertilizer recommendations for coffee and adjustments in the recommendations are expected in the near future.

The summary of results given below of experiments carried out in three locations can be used as a basis for improving these recommendations.

Arabica Coffee--Arabica coffee is grown on all three types of soils described above. Response to N has been good (about 5.5 kg coffee/kg N at 100 kg N/ha) except in Santa on very desaturated ferrallitic soils when no potash was applied (Tables I-7 and I-8). However, in an NPK experiment also in Santa, responses to both N and K were observed and this led to recommendations of both N and K application on the very desaturated ferrallitic soils or Ultisols. No response to P was observed from the data collected.

Robusta Coffee--Robusta coffee responses to N, P, and K are shown in Tables I-9 and I-10. Data from Barombi Kang on ferrallitic soils are shown for a 4-year average time period and for response to N for the first year after regeneration cutback. An average of 2.2-2.5 kg of coffee was produced per kilogram of N for the first 100 kg N/ha. No response to P or K was observed. At Abong Mbang on desaturated ferrallitic soil, an average of 1.8 kg of coffee/kg of N response is estimated from the first 100 kg N/ha; 100 kg K_2O/ha would give 120 kg/ha of coffee.

Table 1-7. Arabica Coffee Response to Nitrogen, Phosphorus, and Potassium

Nutrient Rate (kg/ha)	Yield (Clean Coffee)[a] Location/Variety: Foumbot[b] Java	Foumbot[b] Catura	Santa[c] Java
	(kg/ha)		
Response to N			
0	205	243	659
50	524	712	651
100	999	877	579
200	1,358	1,455	539
400	1,299	1,499	533
600	1,118	1,604	508
Response to P_2O_5			
0	1,017	1,385	813
100	994	1,357	807
200	963	1,318	807
Response to K_2O			
0	1,005	1,470	648
100	1,003	1,204	889
200	966	1,386	890

a. Yield for each location is 6-year average.
b. Foumbot: volcanic soil. Example of soil analysis: pH = 6.0, exchangeable Al 0.06 me/100 g, CEC 36.31 meq/100 g, base saturation 62.88%, P_{Bray} = 18 ppm.
c. Santa: ferrallitic soil.

Source: IRA, 1984.

Table I-8. Estimated Response Functions for Arabica Coffee to Nitrogen, Phosphorus, and Potassium

Location	Variety	Regression Coefficient[a] Intercept	Linear	Quadratic	R^2
Response to N					
Foumbot	Java	287	6.49	-0.0087	0.91
		(132)	(1.31)	(0.0021)	
	Catura	352	6.03	-0.0068	0.94
		(127)	(1.27)	(0.0021)	
Santa	Java	632	-.24	NS	0.76
		(21)	(.068)	NS	
Response to P_2O_5					
Foumbot	Java	1,018	NS	NS	-
	Catura	1,387	NS	NS	-
Santa	Java	812	NS	NS	-
Response to K_2O					
Foumbot	Java	1,010	NS	NS	-
	Catura	1,395	NS	NS	-
Santa	Java	688	1.21	NS	0.75
		(89.4)	(0.69)	NS	

a. NS = not significant at P = 0.05. Numerals in parentheses are values of standard error.

Source: Equations derived by IFDC from yields (clean coffee) in Table I-7, provided by IRA.

Table I-9. Robusta Coffee Response to Nitrogen, Phosphorus, and Potassium

Nutrient Rate (kg/ha)	Yield (Clean Coffee) at Barombi Kang[a] A (kg/ha)	B (kg/ha)	Nutrient Rate (kg/ha)	Yield (Clean Coffee) at Abong Mbang[b] (kg/ha)
Response to N				
0	1,348	819	0	1,128
150	1,678	1,054	100	1,326
300	1,846	1,251	200	1,426
450	1,764	1,054	400	1,481
Response to P_2O_5				
0	1,065		0	1,241
150	1,138		100	1,422
300	931		200	1,319
			400	1,379
Response to K_2O				
0	1,015		0	1,256
140	1,043		100	1,427
280	1,075		200	1,401
			400	1,276

a. Barombi Kang: ferrallitic soil. A is for 4-year average. B is for first year after regeneration cutback.
b. Abong Mbang: desaturated ferrallitic soil. Yield is 10-year average. Example of soil analysis pH = 4.1, exchangeable Al 2.42 meq/100 g, CEC 6.98 meq/100 g, base saturation 17.77%, P_{Bray} = 10 ppm.

Source: IRA, 1984.

Table I-10. Estimated Response Function for Robusta Coffee to Nitrogen, Phosphorus, and Potassium

Location	Regression Coefficient[b]			
	Intercept	Linear	Quadratic	R^2
Response to N				
Barombi Kang[a] A	1,344	3.00	-0.0046	0.99
	(19)	(.20)	(-0.0048)	
B	801	2.76	-0.0048	0.93
	(78)	(.83)	(0.0018)	
Abong Mbang	1,132	2.15	-0.0032	0.99
	(14)	(.17)	(0.0004)	
Response to P_2O_5				
Barombi Kang	1,112	NS	-	-
Abong Mbang	1,301	NS	-	-
Response to K_2O				
Barombi Kang	1,014	NS		-
Abong Mbang	1,270	1.59	-0.0040	0.89
	(47)	(.60)	(0.0014)	

a. A = Average response over first 4 years.
B = Response the first year after regeneration cutback.
b. NS = not significant at P = 0.05. Numerals in parentheses are values of standard error.

Source: Equation derived by IFDC from yields (clean coffee) in Table I-9 provided by IRA.

Also at Barombi Kang no yield responses to lime have been found.

Cotton

Experimental data from Cameroon (Table I-11) (Fritz and Vallerie, 1971) show the benefits of using fertilizer on the major cotton soils. In a large series of missing-element trials, covering the whole of the West African cotton zone, Braud (1974) identified the critical nutrients for the cotton production. Yields decreased significantly when major nutrients were missing, as shown in Table I-12 where the absence of nitrogen and phosphorus and sometimes sulfur and boron showed significant yield decreases.

Plant tissue analysis is used as the basic guide for cotton fertilization recommendations. Specific experiments and on-farm testing of cotton fertilization and the residual effects of this fertilizer on the following food crops serve as the basis for the actual farm-level recommendations. Although these results are not published, they are used by IRA and SODECOTON as a basis for developing national cotton fertilizer recommendations.

Nitrogen management is critical for cotton since different physiological stages, flowering and boll formation, occur at the same time. As a result, N supply to the crop has to be adequate at all times. The recommendations for N fertilization call for 40-55 kg N/ha depending on rainfall.

In the Extreme North Province, the recommendation is to apply all the nitrogen at planting. The limited rainfall of this zone will not leach the nitrogen beyond the root system, and adequate N nutrition is therefore guaranteed with only a single application of N.

In the higher rainfall areas nitrogen should be split, with a second application of 23 kg N/ha at about 40 days after planting.

Phosphorus deficiency is a major constraint for cotton production; only the alluvial soils have adequate available phosphorus. Fritz and Vallerie (1971) have established the critical limits for available P levels in soil (Olson-Dabin method) as 43-55 ppm P and the critical P content in cotton leaves as 0.28% to 0.34%.

Available phosphorus in soil decreases from north to south as soils change from ferruginous to ferrallitic. Also, in the extreme southern portion of the cotton zone, soils fix phosphorus strongly so that careful phosphate fertilizer management techniques must be used.

Fritz and Vallerie (1971) reported medium to high levels of exchangeable K in Cameroon soils where cotton is grown. They found that none of the 27

Table I-11. Average Effect of Recommended Fertilizers on Cotton Yields by Major Soil Type in Cameroon

Soil Types	Yields (Seed Cotton) Recommended Fertilizer Treatment	No Fertilizer	Difference
	(kg/ha)		
Alluvial	1,912	1,410	502
Ferr ginous	1,986	1,243	743
Halomorphic	999	653	843
Vertisols	1,387	805	582
Red tropical	2,100	915	1,180

Source: Fritz and Vallerie, 1971.

Table I-12. Average Cotton Yield (Seed Cotton) Decrease in Missing-Element Trials, West Africa

Missing Element	Yield Decrease (kg/ha)
-N	248 to 925
-P	131 to 924
-K	No effect
-S	65 to 414
-B	81 to 143

Source: Braud, 1974.

soils examined had less than 0.08 milliequivalent (meq)/100 g exchangeable K (the critical level for K deficiency in sandy soils). Even considering the potential K deficiency level of 0.2 meq/100 g of soil as used in the Fertility Capability Classification system (Buol, 1972), few soils in the cotton area would be listed as potentially K deficient. However, K deficiency may develop on some soils under intensive continuous cultivation.

Crop production in the cotton zone is quite intense and large amounts of plant nutrients are removed from the field. Because of the fragile nutrient balance of the soil, adequate and balanced fertilization combined with good crop residue management is needed.

Although potassium has not been identified as a critical factor for cotton production in Cameroon, Braud (1974) showed the interrelation between N, P, K, and S nutrient uptake and concluded that there was a need for these four nutrients in the cotton formula. SODECOTON recommends additional complex fertilizer that includes potash when intensive cotton is followed by a high-yielding crop of maize or sorghum. Unless organic residues are recycled under this system, potash could become deficient. After boron was identified by Fritz (1971) as a critical nutrient for cotton in Cameroon, it was included in the fertilizer formula. A complete N, P, K, S, and B complex fertilizer was adopted for Cameroon cotton growers.

Traditionally, all the nutrients except N are applied on the cotton for the cotton-based rotation, and the following food crops benefit from residual P and K. Fertilizer recommendations for cotton, therefore, have been thought of in terms of the whole rotation and not of the cotton crop only.

Maize

Until recently all fertilizer response work on maize was carried out using pure stands of the crop with adequate plant population density. The results of this work show the great value of fertilizers in production and have led to useful fertilizer recommendations, particularly for the North and Extreme North Provinces where sole cropping is standard practice.

The relevance of the research to the complex maize-intercropped systems of the North West and West has been challenged, and this is the reason for the major emphasis now being placed on a cropping systems approach to soil fertility management. Results from this much needed work are becoming available, but the very nature of the field plot work often leads to coefficients of variation

(CVs) of 30% or more, meaning that as yet uncontrolled factors influence crop response to fertilizers and that sound conclusions cannot be drawn from only a few years' experiments on a limited number of sites.

Maize is cropped in association with many other crops in the high-rainfall zones of the South and West, but in the North it is grown in pure stands, usually following the cotton crop or after the groundnuts in the cotton-groundnut-maize rotation.

Maize yield responses to N, P, and K from experiments in which maize followed cotton or groundnut in the North are shown in Table I-13. The experiments were conducted with high-yielding varieties for 2 years. The most obvious results from the trials are the more frequent and greater response to P when maize followed groundnut than when it followed cotton (Table I-14). Another finding is that maize following cotton generally required more N to reach maximum yield than maize following groundnut. Both findings are logical since most cotton is fertilized at higher levels than most groundnut and groundnut, being a legume, would be expected to leave greater levels of N in soil than would cotton.

Maize following either groundnut or cotton gave increasing yields beyond the 100 kg N/ha. Yield increases from 100 kg N/ha were more than 1.0 mt/ha following groundnut and more than 1.5 mt/ha following cotton. Generally, when following groundnut, maize yield increases were greater than 1.0 mt/ha from 60 kg P_2O_5/ha.

There is some indication in the North that K additions may depress yield although this was significant only at Soucoundou when maize followed groundnut. The situation should be monitored, and if it is found that K fertilization actually depresses yields, determination of magnesium status of plants and soils should be included in further investigations. Some investigations on possible responses of maize to other nutrients have been made (Table I-15), but results are inconclusive.

Additional experiments at other locations in the maize belt of Cameroon show good responses of maize to N and P near Ekona, Yaounde, and Ntui but only response to P at Mbam Mboum (Table I-16).

In the Adamaoua and North West Provinces where acid, high P fixing soils are found, experiments with lime in association with P applications were conducted (Table I-17). The results show strong responses to P in both cases, but response to lime only on Mbo Plain. Interaction between lime and P applications on maize response was only found on Mbo Plain (North West Province),

Table I-13. Maize Response to Nutrients After Groundnut or Cotton in North Cameroon[a]

Nutrient Rate N	P_2O_5	K_2O	Maize Yield Soucoundou	Sanguere	Touboro	Tchollire	Fignole
(kg/ha)			(kg/ha)				
After Groundnut							
0	0	0	2,314	3,942	2,987	3,204	2,828
0	0	60	2,236	4,047	3,256	3,731	3,535
0	60	0	3,770	5,222	3,674	4,217	3,205
0	60	60	2,652	5,285	4,599	4,744	3,512
50	0	0	2,366	5,180	5,406	3,974	3,795
50	0	60	2,080	4,320	5,466	4,258	3,512
50	60	0	3,666	6,879	5,615	5,049	3,700
50	60	60	3,042	6,753	5,615	5,637	3,983
100	0	0	2,800	5,285	6,571	4,663	3,913
100	0	60	2,470	4,299	6,302	4,623	4,101
100	60	0	3,770	6,795	6,451	4,400	4,172
100	60	60	2,233	7,487	5,854	4,805	4,030
150	0	0	2,392	5,432	6,063	4,805	3,606
150	0	60	1,872	4,615	5,884	4,339	3,535
150	60	0	2,964	6,648	7,228	5,454	3,748
150	60	60	2,808	7,319	5,914	4,339	4,031
After Cotton							
0	0	0	2,106	2,810	2,285	2,900	2,946
0	0	60	2,210	2,453	2,576	3,772	3,653
0	60	0	2,002	3,166	2,778	4,196	3,418
0	60	60	1,846	2,432	2,934	4,197	3,276
50	0	0	1,924	3,187	5,018	5,729	4,738
50	0	60	1,820	3,271	4,570	5,352	4,596
50	60	0	1,950	3,691	4,839	5,281	4,714
50	60	60	2,054	4,761	4,861	5,470	4,785
100	0	0	1,482	3,754	5,264	6,649	4,761
100	0	60	1,976	3,859	5,354	6,460	4,667
100	60	0	2,522	4,614	5,600	7,072	6,105
100	60	60	1,872	5,096	5,622	6,601	5,374
150	0	0	1,716	4,173	5,735	6,295	4,879
150	0	60	1,794	4,572	6,160	6,389	4,691
150	60	0	1,872	4,970	5,488	6,813	5,492
150	60	60	2,184	4,425	6,093	6,719	4,596

a. Source: IRA, 1984.

Table I-14. Estimated Response Functions for Maize

Location	Regression Coefficients/Standard Error							
	Intercept	N	N^2	P	P^2	NP	PK	R^2
N, P, K After Groundnut								
Soucoundou	2,316	NS	NS	20.44	-	NS	-0.239	0.75
	(113)	-	-	(3.26)	-	-	(0.063)	
Sanguere	3,711	25.47	-0.112	31.81	-	NS	NS	0.89
	(248)	(7.07)	(0.045)	(3.77)	-	-	-	
Touboro	3,457	46.18	-0.192	6.28	-	NS	NS	0.88
	(251)	(7.16)	(0.046)	(3.81)	-	-	-	
Tchollire	3,463	17.34	-0.064	18.85	-	-0.111	NS	0.63
	(276)	(6.99)	(0.043)	(5.99)	-	(0.064)	-	
Fignole	3,247	15.40	-0.080	NS	-	NS	NS	0.64
	(110)	(3.54)	(0.023)	-	-	-	-	
N, P, K After Cotton								
Soucoundou	1,958	NS	NS	NS	-	NS	NS	-
Sanguere	2,398	24.24	-0.081	10.58	-	NS	NS	0.84
	(217)	(6.19)	(0.040)	(3.29)	-	-	-	
Touboro	2,709	47.18	-0.177	NS	-	NS	NS	0.96
	(140)	(4.51)	(0.029)	-	-	-	-	
Tchollire	3,545	46.70	-0.183	5.84	-	NS	NS	0.94
	(181)	(5.18)	(0.033)	(2.76)	-	-	-	
Fignole	3,325	36.04	-0.170	-	-	NS	NS	0.80
	(195)	(6.28)	(0.040)	-	-	-	-	
NP Trials								
Ekona	6,045	32.11	-0.144	13.33	-	NS	-	0.83
	(311)	(9.41)	(0.067)	(3.68)	-	-		
Yaounde	3,504	29.82	-0.066	49.22	-0.463	-0.116	-	0.91
	(345)	(8.72)	(0.058)	(12.39)	(0.124)	(0.064)		
Ntui	5,637	3.78	NS	7.78	-	NS	-	0.68
	(162)	(1.55)	-	(2.12)	-	-		
Mbam Mboum	1,898	NS	NS	11.70	-0.039	0.068	-	0.83
	(159)	-	-	(5.84)	(0.040)	(0.019)		

Note: Numerals in parentheses are values of standard error; NS = not significant at P = 0.10; and - is not applicable.

Source: Equation derived by IFDC from grain yields in Table I-13 provided by IRA.

Table I-15. Maize Yield Changes Due to Sulfur, Magnesium, or Zinc Application in Cameroon

Location	Preceding Crop	Yield Change		
		S	Zn	Mg
		- - - - - - - - - -	-(%)- - - - - - - - -	
Sanguere	Cotton	-6.1	-7.8	-3.3
	Groundnut	-5.0	-12.3	-1.4
Touboro	Cotton	+8.8	-6.4	-9.6
	Groundnut	+2.5	+6.1	+11.2
Tchollire	Cotton	+4.3	+3.6	+2.2
	Groundnut	+7.6	+0.9	+1.3
Fignole	Cotton	-19.7	-6.1	-0.9
	Groundnut	+3.5	+4.1	+12.9
Soucoundou	Cotton	-5.6	-1.4	0
	Groundnut	+80.5	+39.7	+52.5

Source: IRA, 1984.

Table I-16. Maize Response to N and P Application[a]

Nutrient Rate		Maize Yields			
N	P_2O_5	Ekona	Yaounde	Ntui	Mbang Mboum
(kg/ha)		(kg/ha)			
0	0	5,600	3,600	5,700	1,966
0	45	6,800	4,900	6,200	2,107
0	90	7,800	4,300	6,200	2,312
0	135	-	-	-	2,815
45	0	6,900	4,600	5,800	2,029
45	45	7,600	5,300	5,700	2,532
45	90	8,100	4,500	6,500	3,208
45	135	-	-	-	3,617
90	0	8,700	5,700	5,800	1,730
90	45	8,400	6,800	6,800	2,280
90	90	8,800	6,000	6,900	3,051
90	135	-	-	-	3,177
135	0	7,500	6,300	6,100	2,029
135	45	8,500	6,900	6,600	2,800
135	90	8,800	5,300	6,600	4,089
135	135	-	-	-	3,743

a. Ekona: volcanic soil; Yaounde, Ntui, and Mbang Mboum: ferrallitic soils. Example of soil analysis Ekona: pH = 4.3, exchangeable Al 2.07 meq/100 g, CEC 6.12 meq/100 g; Ntui: pH = 4.5, exchangeable Al 1.67 meq/100 g, CEC 13.12 meq/100 g, base saturation 19.44%, P_{Bray} = 4 ppm.

Estimated Response Functions Are:

Ekona $y = 6{,}045 + 32.11N - 0.144N^2 + 13.33P$ $\quad R^2 = 0.83$
(311) (9.41) (0.067) (3.68)

Ntui $y = 5{,}637 + 3.79N - 7.78P$ $\quad R^2 = 0.68$
(162) (1.55) (2.12)

Mbam Mboum $y = 1{,}898 + 11.70P - 0.039P^2 + 0.068NP$ $\quad R^2 = 0.83$
(159) (5.84) (0.040) (0.019)

Yaounde $y = 3{,}504 + 29.82N - 0.066N^2 + 49.22P - 0.463P^2 - 0.116NP$ $\quad R^2 = 0.91$
(345) (8.72) (0.058) (12.39) (0.124) (0.064)

Numerals in parentheses are values of standard errors.

Source: IRA, 1984, for yield response data. Equations derived by IFDC from grain yields in Table I-16 provided by IRA.

Table I-17. Maize Response to Lime and Phosphorus Rates at Two Locations[a]

P_2O_5 Rate (P) (kg/ha)	Maize Yield — Lime Rate (L) (kg/ha) 0	500	1,000	2,000	4,000	Mean
	(kg/ha)					
Wassande						
0	402	301	307	484	476	394
75	2,851	2,716	2,964	2,807	2,876	2,843
150	4,053	4,221	4,312	4,451	4,360	4,279
225	4,636	5,251	4,719	5,437	4,464	4,901
Mean	2,986	3,122	3,076	3,295	3,044	3,104
Mbo Plain						
0	1,137	-	881	1,921	1,949	1,472
50	1,813	-	3,837	3,666	3,728	3,261
100	2,967	-	4,493	4,757	5,391	4,402
150	2,804	-	4,401	5,588	5,577	4,592
Mean	2,180	-	3,403	3,983	4,161	3,432

a. Average yields over three experiments in Wassande; an example of analysis of these ferrallitic soils is as follows: pH = 4.55, exchangeable Al = 1.39 meq/100, CEC (NH_4AC 1N pH7) = 10.8, P Olsen = 10.5.

Estimated Response Functions Are:

Wassande $Y = 404 + 38.21\ P - 0.081\ P^2$
(99) (2.1) (0.009)

Mbo Plain $Y = 593 + 40.15\ P\ \ 0.160\ P^2 + 1.135\ L - 0.00021\ L^2 + 0.00276\ PL$
(307) (6.76) (0.041) (0.266) (0.00006) (0.00124)

Numerals in parentheses are standard errors.

Source: IRA, 1984, for yield response data. Equations derived by IFDC from grain yields in Table I-17 provided by IRA.

indicating increasing response to P with increasing lime applications up to 4 mt/ha.

On the high phosphate-fixing soils, P fertilizer placement is essential: fertilizer must be near the seed and localized rather than dispersed in soil. Experiments carried out in Wassande (Adamaoua Province) on maize have shown that band placement is superior to broadcast P applications.

Previously it was stated that investigations are underway on crop response to fertilizer in mixed cropping systems. Yield data for maize and legumes grown together with and without fertilizer are shown in Table I-18. At three of the four locations the response of local maize to fertilizer was better than the average response of improved varieties. On the average, the legume yield was unaffected by maize variety or fertilizer.

Sorghum

Sorghum is a staple cereal of the North and Extreme North Provinces. It is grown in pure stands under a wide range of conditions--during the rainy season in rotation with cotton (dryland sorghum) and as a transplanted crop using residual moisture in the dry season (the Muskwari crop on the Vertisols and the Babouri crop on hydromorphic alluvial soils).

Local varieties of sorghum and millet respond poorly to fertilizers, but newly selected varieties of sorghum are highly productive and responsive to N, P, and sometimes even to K.

Responses of newly selected improved varieties (S-35 and S-34) of dryland sorghum to N, P, and K fertilizer are shown in Tables I-19 and I-20. Responses were obtained to N at the four locations, to P at two locations, and to K at one location. Generally, yield increases of about 1 mt/ha were obtained with up to 70-90 kg N/ha. Where responses to P were obtained, about 10 kg of grain was produced per kilogram of P_2O_5. Among the nutrients, nitrogen provides not only more frequent but also the largest response, but the other nutrients may be necessary for maximum yields at some locations. These experiments need to be continued and the relation of responses to soil properties studied in order to formulate balanced fertilization recommendations.

Sorghum grown after cotton benefits from the residual effects of the cotton fertilizer. Therefore, reasonably high sorghum yields can be obtained using only nitrogen fertilizer. New highly productive varieties may, however, have additional fertilizer requirements.

Table I-18. The Influence of Maize Variety on Crop Yield Responses to Fertilizer in Mixed Maize-Legume Cropping Systems

Maize Variety	Crop Yield by Location															
	Ndop				Bamenda				Haut Plateau				Menchum Valley			
	Maize		Bean		Maize		Groundnuts		Maize		Groundnuts		Maize		Groundnuts	
	+F	-F	+F	-F	+F	-F	+F	-F	+F	-F	+F	-F	+F	-F	+F	-F
	(tons/ha)															
COC	1.55	0.99	0.34	0.19	2.28	2.53	0.21	0.33	-	-	-	-	-	-	-	-
BAC	1.37	0.67	0.24	0.25	2.64	2.00	0.33	0.32	-	-	-	-	-	-	-	-
MLC	2.27	1.13	0.28	0.22	3.75	2.71	0.19	0.35	3.91	3.98	0.10	0.09	2.34	0.93	0.09	0.11
KAS	2.11	1.30	0.27	0.19	2.98	2.54	0.46	0.47	4.76	4.32	0.09	0.06	3.94	3.39	0.12	0.16
SAW	-	-	-	-	-	-	-	-	4.27	4.26	0.09	0.13	-	-	-	-
PH	-	-	-	-	-	-	-	-	4.16	5.02	0.11	0.12	-	-	-	-
EKW	-	-	-	-	-	-	-	-	-	-	-	-	3.62	4.38	0.16	0.17
EKY	-	-	-	-	-	-	-	-	-	-	-	-	2.95	3.80	0.07	0.13
Mean																
Improved	1.82	1.02	0.28	0.21	2.91	2.44	0.30	0.37	4.28	4.40	0.10	0.10	3.21	3.12	0.11	0.14
Local	1.53	1.01	0.25	0.15	2.81	1.94	0.25	0.30	4.06	2.86	0.08	0.11	3.00	2.39	0.20	0.21

Source: IRA, 1984.

Table I-19. Response of Improved Sorghum Varieties to Nitrogen, Phosphorus, and Potassium in Dryland Conditions in Northern Cameroon

Nutrient Rate			Grain Yield			
N	P_2O_5	K_2O	Guetale	Bere	Sanguere	Touboro
(kg/ha)			(kg/ha)			
0	0	0	2,957	2,541	2,624	1,375
0	0	40	3,249	2,561	3,520	1,500
0	40	0	3,416	2,312	3,249	1,749
0	40	40	3,207	2,437	3,395	1,728
40	0	0	3,478	2,895	3,873	1,895
40	0	40	3,249	3,207	3,478	2,395
40	40	0	3,187	3,207	4,477	2,270
40	40	40	4,290	3,062	4,561	2,603
80	0	0	3,603	3,520	3,728	2,770
80	0	40	3,332	3,353	4,144	2,458
80	40	0	3,645	3,582	4,519	2,374
80	40	40	3,561	3,666	3,832	3,186
120	0	0	3,894	3,499	3,603	2,353
120	0	40	3,728	3,520	3,686	2,791
120	40	0	4,269	3,415	3,124	2,249
120	40	40	4,103	3,290	4,040	2,291

Source: IRA, 1984.

Table I-20. Estimated Sorghum Yield Response Functions

Location	Regression Coefficient[a]							R^2
	Intercept	N	N^2	P	K	NP	PK	
Guetale	3,118	7.35	NS	NS	NS	NS	0.254	0.64
	(120)	(1.81)	NS	NS	NS	NS	(0.109)	
Bere	2,445	22.03	-0.114	NS	NS	NS	NS	0.93
	(63)	(2.51)	(0.020)	NS	NS	NS	NS	
Sanguere	2,950	30.12	-0.210	13.72	NS	NS	NS	0.62
	(246)	(7.79)	(-0.060)	(8.00)	NS	NS	NS	
Touboro	1,247	28.03	-0.153	10.11	5.99	-0.121	NS	0.86
	(157)	(4.64)	(0.036)	(4.76)	(2.85)	(0.064)	NS	

a. Numerals in parentheses are values of standard error.

NS = not significant at P = 0.10.

Source: Equation derived by IFDC from grain yields in Table I-19 provided by IRA.

Sorghum grown during the dry season represents 40% of the cereals produced in the North. The limiting factor for dry season sorghum production is, of course, soil moisture availability. Only with Babouri sorghum, when planted early enough to benefit from late rains, is there response to fertilizers. A research program is investigating the possibility of sequence or relay cropping of rice and Muskwari sorghum, but only limited and inconclusive results are so far available.

Rice

North and Extreme North Provinces--The irrigated rice grown under the SEMRY Project uses modern varieties grown under high incident radiation. Response to nitrogen under these conditions is good to excellent. Examples of responses are shown in Tables I-21 and I-22. Maximum yields would be obtained with more than 180 kg N/ha during dry seasons and with more than 150 kg N/ha during wet seasons. On the basis of average responses over the years, 150 kg N/ha would be expected to give 2-3 mt/ha yield increase, depending on location. This would result in 13-20 kg paddy per kg N.

New fertility problems have appeared in recent years and are attributed to an increasingly severe phosphorus deficiency. Much of Yagoua, Maga, and all of the Kousseri area are suspected of being deficient in phosphorus (source: SEMRY). The results from a phosphorus experiment conducted for three seasons are shown in Table I-23. Results show significant response to phosphate application, as well as similar response to triple superphosphate (TSP) and diammonium phosphate (DAP) when each was applied for all crops. Additionally, the data show that one application of TSP followed by three crops gives a yield response similar to that when the TSP is split for each crop. SEMRY has now recommended DAP at the rate of 100 kg/ha for all the phosphate-deficient rice-growing areas.

The Mbo Plain--The Mbo Plain in the West Province is also an important rice-growing area for both upland and transplanted irrigated rice. The soils are acid and low in phosphorus, and incident radiation and temperatures are low.

Experiments on nitrogen source and time of application have been conducted, but results have been inconclusive. Yield responses of irrigated transplanted rice to nitrogen or to nitrogen and phosphorus are shown in Tables I-24 through I-26. Compared with the SEMRY project area, yields with no nitrogen fertilizer are generally greater and maximum yields are obtained at

Table I-21. Response of Irrigated Rice to Nitrogen, SEMRY Project

Location	Year	Paddy Yield N Rate (kg/ha) 0	45	90	135	180
		(kg/ha)				
Dry Seasons						
Vounaloum	1983	3,510	5,010	5,600	5,300	6,240
	1984	4,170	4,740	5,870	7,040	7,150
	1985[a]	4,800	6,050	6,130	6,770	6,590
	1985	1,560	2,920	4,140	4,990	5,410
	Mean	3,510	4,680	5,450	6,020	6,350
Maga	1983	1,880	1,970	2,330	2,520	1,940
	1984	2,470	3,940	4,490	5,670	6,110
	1985	2,420	3,460	3,550	4,630	4,610
	Mean	2,260	3,120	3,460	4,270	4,220
Wet Seasons						
Vounaloum	1983	2,210	3,380	4,590	5,340	5,450
	1984	4,360	5,490	6,370	6,670	7,560
	Mean	3,280	4,440	5,480	6,000	6,500
Maga	1983	3,040	4,340	4,450	4,950	4,720
	1984	3,210	4,420	5,290	5,620	5,580
	Mean	3,120	4,380	4,870	5,280	5,150
Kousseri	1983	3,710	4,990	5,220	5,560	5,290
	1984	4,120	4,680	6,120	6,510	7,090
	Mean	3,920	4,840	5,670	6,040	6,190

a. Two experiments were analyzed in 1985.

Example of soil analysis:
Kousseri (1984): pH $CaCl_2$ = 5.2, CEC = 19.3 meq/100 g, P_2O_5 30 ppm
Exchangeable Na (1969) 0.8 meq/100 g, exchangeable K (1969) 1.0 meq/100 g
(1984) 6.3 meq/100 g, (1984) 3.9 meq/100 g
(Ca + Mg)/K (1969) = 24.0 (optimum)
(1984) = 2.9 (very low)

Source: SEMRY.

Table I-22. Estimated Response Function for Rice to Nitrogen, SEMRY Project

Location	Year	Regression Coefficients[a] Intercept	N	N^2	R^2
Dry Seasons					
Vounaloum	1983	3,695 (483)	26.0 (13.0)	-0.071 (0.068)	0.87
	1984[b]	4,016 (344)	24.0 (9.1)	-0.031 (0.048)	0.96
	1985[b]	4,875 (235)	25.0 (6.2)	-0.085 (0.033)	0.95
	1985	1,529 (63)	36.0 (1.6)	-0.079 (0.088)	0.99
	Mean	3,529	27.75	-0.066	
Maga	1983	1,778 (219)	11.0 (5.8)	-0.053 (0.031)	0.68
	1984	2,530 (235)	29.0 (6.2)	-0.050 (0.033)	0.98
	1985	2,463 (322)	20.0 (8.5)	-0.040 (0.045)	0.93
	Mean	2,257	20.0	0.048	
Wet Seasons					
Vounaloum	1983	2,137 (145)	35.0 (3.8)	-0.091 (0.02)	0.99
	1984	4,423 (213)	24.0 (5.6)	-0.037 (0.030)	0.98
	Mean	3,280	29.50	-0.064	
Maga	1983	3,125 (236)	26.0 (6.2)	-0.094 (0.033)	0.96
	1984	3,202 (30)	33.0 (0.8)	-0.107 (0.004)	0.99
	Mean	3,163	29.50	-0.101	
Kousseri	1983	3,781 (176)	27.0 (4.6)	-0.105 (0.025)	0.97
	1984	4,263 (283)	28.0 (7.5)	-0.071 (0.040)	0.96
	Mean	4,022	27.50	-0.088	

a. Numbers in parentheses are values of the standard error.
b. Two experiments were analyzed in 1985.

Source: Equation derived by IFDC from grain yield in Table I-21 provided by SEMRY.

Table I-23. Response of Rice to Phosphorus Rates, Sources and Management Practices, SEMRY Project

P Source	P_2O_5 Rate By Crop 1	2	3	Paddy Yield[a] Year and Season: 1983 Wet	1984 Dry	1984 Wet	Total	Agronomic Efficiency: 1 Crop	2 Crops	3 Crops
				(kg/ha)				(kg paddy/kg P_2O_5)		
-	0	0	0	1,400	2,300	2,520	6,220	-	-	-
DAP	45	45	45	2,670	3,650	3,090	9,410	28.2	29.1	23.6
	90	90	90	2,410	4,330	2,920	9,660	11.2	16.9	12.7
TSP	45	45	45	2,850	2,550	3,460	8,860	32.2	18.9	19.6
	90	90	90	2,840	3,270	3,900	10,010	16.0	13.4	14.0
	180	180	180	3,290	3,310	3,780	10,380	10.5	8.1	7.7
	360	360	360	3,460	4,070	3,600	11,130	5.7	5.3	4.5
TSP	90	-	-	3,130	2,420	2,470	8,020	19.2	20.6	20.0
	180	-	-	2,870	2,830	2,650	8,350	8.2	11.1	11.8
	360	-	-	3,140	3,310	3,210	9,660	4.8	7.6	9.6

a. All plots received 90 kg N/ha for each crop.

Estimated Response Functions for TSP:

Crop 1

$$Y = 1{,}860 + 12.48\,P - 0.024\,P^2 \qquad R^2 = 0.71$$
$$(333) \quad (4.54) \quad (0.011)$$

Crop 1 & 2

P each crop

$$Y = 4{,}148 + 10.97\,P - 0.0088\,P^2$$
$$(396) \quad (3.16) \quad (0.0041)$$

P first crop

$$Y = 4{,}148 + 13.74\,P - 0.021\,P^2 \qquad R^2 = 0.92$$
$$(396) \quad (6.01) \quad (0.016)$$

Crop 1, 2, & 3

P each crop

$$Y = 6{,}878 + 11.54\,P - 0.0071\,P^2$$
$$(593) \quad (3.16) \quad (0.0027)$$

P first crop

$$Y = 6{,}878 + 10.75\,P - 0.0086\,P^2 \qquad R^2 = 0.91$$
$$(593) \quad (9.02) \quad (0.024)$$

Numbers in parentheses are standard errors.

Source: SEMRY, 1984. Equations derived by IFDC from grain yields in Table I-23 provided by SEMRY.

Table I-24. Nitrogen Response of Irrigated Rice, Mbo and Ndop Plain

N Rate (kg N/ha)	Paddy Yield		
	Mbo 1983 (1)	Mbo 1984 (1)	Ndop 1984
	(kg/ha)		
0	4,980	4,360	4,360
20	5,300	4,840	5,010
40	5,660	5,590	5,370
60	5,570	5,580	5,990
80	5,490	6,020	5,940
100	6,110	5,930	5,870
120	5,180	-	-

Example of soil analysis:
Mbo pH 4.2, CEC = 7.09 meq/100 g, base saturation 39%, P_{Bray} 3.7 ppm.
Ndop pH 4.6, CEC = 7.29 meq/100 g, base saturation 69%, P_{Bray} 0.9 ppm.

Source: IRA, 1983, 1984.

Table I-25. Effect of P and N Rates on Yield of CICA-8 Rice Under Irrigated Condition, Mbo Plain

N Rate (kg/ha)	Paddy Yield[a] — P_2O_5 Applied (kg/ha) 0	40	60	80	Mean
	(kg/ha)				
1982 Wet Season					
0	4,830	4,360	4,690	5,220	4,780
40	5,530	5,340	5,800	4,930	5,400
60	4,520	5,680	4,630	4,900	4,930
80	5,210	5,990	5,510	5,520	5,560
100	5,100	5,750	5,870	5,850	5,640
Mean	5,040	5,420	5,300	5,280	-
1983 (2) Wet Season (Late)					
0	2,080	1,810	2,070	2,190	2,040
40	2,630	2,430	2,590	2,720	2,590
60	2,210	2,590	2,780	2,930	2,630
80	2,800	2,740	2,920	2,900	2,840
100	2,610	2,580	3,200	2,700	2,770
Mean	2,470	2,430	2,710	2,690	-
1984 (2) Wet Season					
0	5,640	5,600	5,710	5,300	5,560
40	5,910	6,120	6,270	5,610	5,980
60	5,800	5,870	6,230	6,030	5,980
80	6,410	6,800	7,270	6,290	6,690
100	6,730	6,530	7,180	7,300	6,930
Mean	6,100	6,180	6,530	6,100	-

a. Average of 3 replications. 1982: CV = 12.0%, LSD (5%) = 0.8 mt/ha; 1983: CV = 23.5%, not significantly different; 1984: CV = 8.5%, LSD (5%) = 0.90 mt/ha.

Source: IRA.

Table I-26. Estimated Response Function for Irrigated Rice Mbo Plain

Location	Year	Regression Coefficients						
		Intercept	N	N^2	P	P^2	NP	R^2
Mbo	1983 (1)	4,958 (268)	21.24 (10.47)	-0.147 (0.084)	-	-	-	0.54
	1984 (1)	4,330 (147)	35.00 (6.90)	-0.183 (0.066)	-	-	-	0.96
	Mean	4,644	28.12	-0.165	-	-	-	-
Mbo	1982	4,597 (241)	8.04 (2.75)	NS	NS	NS	NS	0.40
	1983 (2)	1,890 (109)	16.00 (3.9)	-0.089 (0.038)	3.33 (1.38)	NS	NS	0.77
	1984 (2)	5,449 (141)	13.94 (2.14)	NS	NS	NS	NS	0.70
	Mean	3,979	12.66	-0.089	3.33			
Ndop	1984	4,351 (119)	39.06 (5.59)	-0.237 (0.054)	-	-	-	0.97

Numbers in parentheses are standard errors.

Source: Equations derived by IFDC from grain yield data in Table I-25 provided by IRA.

lower rates of nitrogen in the Mbo Plain. Nitrogen application rates for maximum yield vary from 71 to 95 kg N/ha allowing yields to reach up to 6 mt/ha. Response to phosphate (Table I-25) is nil to small. The general lack of response of rice to phosphorus leads to inconclusive results from several experiments in which phosphorus sources, including phosphate rock, were compared. Expending effort on such comparisons has little practical value in that, per unit of P_2O_5, phosphate rock is more expensive than DAP when applied in the field.

Upland rice is not usually fertilized although studies on the fertilizer response of this crop are being carried out. The limited data collected for this study (Tables I-27 through I-29) indicate small responses of rainfed rice to nitrogen, phosphorus, and potassium.

Summary

A limited amount of data on crop response to fertilizers was collected and analyzed. The results indicate the following:

1. Coffee, Arabica and Robusta, responds well to N even at rates greater than 100 kg N/ha. Response to other nutrients was limited to K in the desaturated ferrallitic soils.
2. Cotton yield responses of 0.5-1.0 mt seed cotton/ha were reported due to fertilization.
3. Maize yield responses to 100 kg N/ha were 1.0 mt/ha or more following groundnut and 1.5 mt/ha or more following cotton in the North. Yield responses to P_2O_5 were good following groundnut but infrequent following cotton, indicating the value of residual fertilizer.
4. Sorghum yields increased consistently with nitrogen (1 mt of grain/ha from 70-90 kg N/ha), but responses to P and K were less frequent.
5. Excellent rice yield responses to N were obtained in the SEMRY project area (2-3 mt paddy/ha from 150 kg N/ha). Also, yield increases were obtained with phosphate. DAP and TSP applied as split doses to each crop or at one time for three crops gave similar yield responses.

   On the Mbo Plain yields without N were greater than those in the SEMRY project, and maximum yields were obtained with less than 100 kg N/ha. Even though soils are reported to be low in P, the data collected indicate only zero to small yield responses to P.

Table I-27. Response of IRAT-10 Rice to N and P Under Rainfed Upland Condition, Mbo Plain, 1983 Wet Season

Nutrient Rate N	Nutrient Rate P_2O_5	Grain Yield[a]
(kg/ha)	(kg/ha)	(kg/ha)
0	0	1,620
40	0	2,260
60	0	2,680
80	0	1,720
40	60	1,770
60	60	2,690
80	60	2,690
40	80	2,560
60	80	3,040
40	100	2,910
60	100	2,510
80	100	2,910

a. Average of three replications; LSD (5%) = 710 kg/ha; CV = 17.08%.

Estimated response function as follows:

$$Y = 1{,}560 + 26.5N - 0.254N^2 + 0.103NP$$
$$(367)\ (15.9)\ (0.166)\ (0.048) \qquad R^2 = 0.58$$

Numbers in parentheses represent the standard error.

Source: IRA.

Table I-28. Response of Rainfed IRAT-10 Rice to Phosphorus, Mbo Plain, 1984

P_2O_5 Rate	Paddy Yield: Trial 1	Paddy Yield: Trial 2 Broadcast	Paddy Yield: Trial 2 Band
(kg/ha)	(tons/ha)	(tons/ha)	(tons/ha)
0	2.37	1.19	1.19
50	2.82	1.34	1.73
100	3.08	1.39	1.84
150	3.30	-	-
200	3.55	1.64	2.02

Estimated response function for trial 1 is:

$$Y = 2{,}391 + 8.30P - 0.013P^2$$
$$(44)\ (1.03)\ (0.0005) \qquad R^2 = 0.99$$

Numbers in parentheses are values of standard error.

Source: IRA.

Table I-29. Response of Rice Variety IRAT-10 to K Under Rainfed-Upland Condition, Mbomi-10 (Mbo Plain), 1984 Wet Season

K_2O Rate (kg/ha)	Paddy[a] Yield (kg/ha)	% Grain Sterility
0	2,342	17.6
20	2,873	16.0
40	2,800	14.6
60	2,742	11.7
80	2,621	14.0

a. Average of four replications; LSD (0.05) = 540 kg/ha; CV = 13.1%.

The estimated response function is:

$$Y = 2{,}406 + 20.55K - 0.230K^2$$
$$(127) \quad (7.5) \quad (0.090) \qquad R^2 = 0.79$$

Numbers in parentheses are values of standard error.

Source: IRA, 1984.

Crop Responses to Fertilizers in Cameroon--
Economics of Fertilizer Use

An objective of this study was to establish farmer benefit/cost ratios when fertilizer is used on the principal crops at recommended rates. Coffee, cotton, maize, and rice account for 82% of the fertilizer used in Cameroon. Although fertilizer recommendations exist for most crops, even for the major crops there is great difficulty in obtaining adequate information on the profitability of farm use of fertilizer.

In the coffee-food crop mixed cropping system of the western area of Cameroon, work on the effect of fertilizer on total crop production has only recently begun. In the cotton zone, SODECOTON has developed general fertilizer recommendations that are based on total soil fertility evolution and not on the response of cotton to the individual fertilizer nutrients.

The approach used in determining physical response was to take the raw agronomic results from IRA research and develop response curves using regression techniques for coffee, maize, sorghum, and rice, and the results were used to determine the economics of fertilizer use. As crop budgets were not available, partial budgeting was used to determine benefit/cost ratios for fertilizer use for a number of products.

Arabica Coffee

About 40% of the total coffee area is Arabica. The Census indicates that 121,000 ha of Arabica coffee was grown in Cameroon in 1984 (Table I-30). All the Arabica coffee is produced in the West and North West Provinces with about 58% of the area being in the West in 1984. Arabica yields in the North West Province (440 kg/ha) exceed those in the West (358 kg/ha). Arabica yields are low as a result of several factors. Over 22% of the trees are over 25 years old, and 39% range from 13-25 years. Fertilization rates of Arabica coffee are low. Even with the recent figures on coffee areas, which are lower than previous figures in the Census, total fertilizer use if applied at the recommended rates of 200 kg/ha would require over 20,000 mt of fertilizer, more than was used on all coffee in these two provinces in 1985. The Census indicates that 49% of the coffee farmers use fertilizer although no breakdown is given between Arabica and Robusta coffee fertilization.

Although the f.o.b. price of Cameroon Arabica coffee has gone up significantly over the years, the price the farmer receives has typically been

Table I-30. Cameroon: Comparison of Arabica Coffee Statistics

Item	1978/79	1979/80	1980/81	1981/82	1982/83	Census 1984
Production ('000 mt)	27	28	25	25	25	25
Area ('000 ha)	156	158	164	150	153	101
Yield (kg/ha)	173	179	154	167	162	392

Source: Ministry of Agriculture, "Yearbook of Agricultural Statistics, 1982/83 and 1984 Agricultural Census."

Table I-31. Prices of Arabica Coffee

Year	Producer Price	f.o.b. Price	Percent[a]	Year	Producer Price	f.o.b. Price	Percent[a]
	- - (FCFA/kg) - - -				- - (FCFA/kg) - - -		
1961	175	202	87	1973	200	296	68
1962	175	205	85	1974	190	324	59
1963	192	222	86	1975	235	457	51
1964	195	235	83	1976	305	936	33
1965	185	230	81	1977	325	1,032	31
1966	157	214	74	1978	360	1,001	36
1967	156	210	74	1979	350	787	44
1968	158	218	72	1980	340	844	40
1969	201	276	73	1981	370	704	50
1970	174	263	66	1982	450	704	50
1971	165	248	67	1983	410	1,098	37
1972	175	284	62	1984	420	1,275	33

a. Producer price expressed as a percentage of f.o.b. price.

Source: "Bilan Diagnostic" as reported in "Cocoa in Cameroon, Policy and the Economics of Production," Volume I, page 54, Gagne-Gervais, "Cameroon the Cash Crop Sector: Its Performance and Future Development Possibilities," page 11, and Ministry of Agriculture Statistics.

only about half of current price, and the farmer's share has fallen over time (Table I-31).

Costs developed in Tables I-32 and I-33 based on budgets provided by UCCAO indicate that the cost of producing Arabica coffee and achieving a yield level of 392 kg/ha as indicated by the 1984 Census of Agriculture would result in a cost of FCFA 398/kg of Arabica coffee produced. The 1984 Census reported that farmers in the North West and West Provinces received FCFA 280 and 320/kg of Arabica coffee produced in 1984. However, UCCAO reported buying Arabica coffee at FCFA 420/kg. Thus it appears that if farmers receive the price indicated by the Census and if labor is computed at prevailing rates, farmers are losing money from Arabica coffee production. However, farmers obviously value their labor at a lower rate and hope for a good production year; otherwise, they would not keep producing in that often they may not even be covering their variable costs. No doubt this explains why 60% of the trees are over 12 years old and only 10% of all trees are less than 4 years. Farmers cannot afford to replant Arabica coffee, and no doubt over time some of this area will shift to food crops unless the government decides to give the farmer a large share of the f.o.b. Arabica coffee price.

The practice of intercropping presents a problem in developing costs of production. UCCAO personnel estimated that 80% of the crops in the West Province were intercropped. This makes determining average yields, average costs, etc., very difficult. A study by IRA (1983) indicated that 44% of a survey group cited the main advantage of intercropping as "its rational use of the land," 20% cited "the spreading of risk of an individual crop failure," and 18% cited "the efficient use of farm labor." The disadvantage of mixed cropping most cited was "the low yields of the associated crops."

UCCAO figures on Arabica coffee confirm this disadvantage cited in the IRA survey. UCCAO estimates that typical Arabica intercropped yields were 250-260 kg/ha, whereas monocropped producers obtained 400-450 kg/ha. Thus the monocropped producers who manage well are likely making a reasonable profit, whereas the intercropped producer must compute not only his net returns from Arabica coffee but also the value of the intercropped food crops and the value he places in spreading his risk.

UCCAO also indicated that Arabica coffee yields without fertilizer were less than half of that from trees receiving proper fertilization. They also indicated that trees not receiving fertilizer had a life of only 10-15 years.

Table I-32. Total Cost of Establishing Arabica Coffee

	FCFA/ha
Clearing	15,000
Staking (15 days at 600)	9,000
Marking holes (1,100 at 80)	88,000
Seedlings (1,100 at 5)	5,500
Transporting seedlings to plantation	5,000
Transplanting (15 days at 600)	9,000
Fertilizer (25 g x 1,100 x 2)	1,800
Applying fertilizer (2 at 5,000)	10,000
Weeding and cultivation	12,000
Total Year 1	155,300
Weeding, cultivation, etc. (4 at 6,000)	24,000
Transporting organic manure	4,000
Fertilizer (1,100 at 50 g x 2)	2,600
Labor for application	10,000
Total Year 2	40,600
Weeding, cultivation, etc.	24,000
Transporting organic manure	6,000
Fertilizer (1,100 at 75 g x 2)	5,000
Labor for application	10,000
Total Year 3	45,000
Weeding, cultivation, etc.	24,000
Pruning (1,100 at 5 x 2)	5,500
Transporting organic manure	8,000
Fertilizer (1,100 at 100 g x 2)	7,200
Labor for application	10,000
Total Year 4	54,700
Total 4-Year Costs (Establishment Plantation)	295,600
Annual Cost Assumed Over 20 years	14,000

Source: D. Moreau, Directeur of Production, UCCAO, December 1983.

Table I-33. Annual Cost of Producing Arabica Coffee

Activity	FCFA/ha
Establishment cost	14,000
Equipment cost	16,270
Weeding, cultivation, etc. (4 at FCFA 6,000)	24,000
Pruning (1,100 at FCFA 10)	11,000
Transporting organic fertilizer	8,000
Fertilizer 400 kg/ha x FCFA 35/kg)	14,000
Applying fertilizer (2 times at FCFA 5,000/ha)	10,000
Pesticides, fungicides, sprayer rental, etc.	10,000
Labor for applying pesticides and fungicides (5 times at FCFA 5,000)	25,000
Harvesting cost FCFA 100/mt	8,250
Removing pulp	2,000
Fermentation material	3,500
Material for drying FCFA 75/sack	1,500
Transporting and handling coffee	3,500
Other costs	4,480
Total Annual Cost/Hectare	156,000
Cost per kg at 500 kg/ha	312
Cost per kg at 392 kg/ha	398
Cost per kg at 300 kg/ha	520

Source: D. Moreau, Directeur of Production, UCCAO, December 1983.

Three trials have been run by IRA over a 10-year period on the yield response by Arabica coffee to fertilizer use as described earlier in the agronomic section. The trials measured only N response; additional phosphate and potash were used in the trials and the response to N was isolated.

The advantage of fertilizer use can be summarized by using partial budgeting techniques. This means estimating the value of the benefits resulting from fertilization and the associated costs in achieving these benefits. With the use of regression analysis and the research data from the three trials, the following equations were developed to estimate crop response:

1. Foumbot Java $Y = 287.6 + 6.49\ N - .0087\ N^2$ $R^2 = .91$
2. Foumbot Catura $Y = 352 + 6.03\ N - .006755\ N^2$ $R^2 = .94$

where

Y = Arabica yield in kg/ha

N = kg of nitrogen/ha

It was assumed that fertilizer is applied twice at 4 workdays/application/ha at FCFA 1,000/day. Costs of transporting fertilizer and extra output were estimated to be FCFA 2,000/ha.

Results of the trials are summarized in Table I-34, based on both subsidized fertilizer (FCFA 200/kg N) and unsubsidized fertilizer (FCFA 952 kg N), and shown graphically in Figures I-8 and I-9. Fertilizer recommendations for the majority of the Arabica coffee are 200 kg of 20-10-10. Crop value was determined by using the 1984 Census average price received for Arabica coffee (FCFA 300 rather than the official price of FCFA 420). The two trials indicate that fertilizer is profitable at the recommended rate even though the trials are much more profitable at higher application rates. Fertilizer use is profitable even if fertilizer is unsubsidized. Table I-35 indicates that the benefit/cost (B/C) ratios are much more favorable if farmers receive the official stated price for Arabica coffee as an average (FCFA 420). This gives an idea of the sensitivity of the B/C ratio to changes in crop prices when the crops are fertilized at the recommended rate.

A major weakness of this approach is that only response to N was evaluated. Thus, in calculating the economics of fertilizer use, all of the fertilizer cost is charged to N although it is expected that there are also benefits from P and K.

Since these are research results with higher than average management, the farmer's results may be less favorable. In addition, these results were based on monocropping, and results with intercropping may not be as favorable.

Table I-34. Arabica Coffee Net Returns and Benefit/Cost Ratios Using Recommended Fertilization Rate of 200 kg of 20-10-10/ha

Trial	Location	Variety	Yield (kg/ha)	Net Returns From Applying Fertilizer: Subsidized[a] (FCFA/ha)	Net Returns From Applying Fertilizer: Unsubsidized[b] (FCFA/ha)	Benefit/Cost Ratio: Subsidized	Benefit/Cost Ratio: Unsubsidized
1	Foumbot	Java	533	55,800	25,720	4.10	1.53
2	Foumbot	Catura	582	51,000	20,920	3.83	1.44

a. Subsidized = FCFA 200/kg N.
b. Unsubsidized price = FCFA 952/kg N.

Source: Based on response curves developed by IFDC from IRA research data. Coffee prices are based on census average prices received, subsidized fertilizer prices are based on prices charged outside Douala, and nonsubsidized prices are based on IFDC estimates.

Table I-35. Benefit/Cost Ratios Assuming Arabica Coffee Price at FCFA 420/kg

Trial	Location	Variety	Yield (kg/ha)	Benefit/Cost Ratio: Subsidized	Benefit/Cost Ratio: Unsubsidized
1	Foumbot	Java	533	5.74	2.15
2	Foumbot	Catura	582	5.37	2.01

Source: Data sources same as Table I-34 except official Arabica coffee price of FCFA 420/kg assumed.

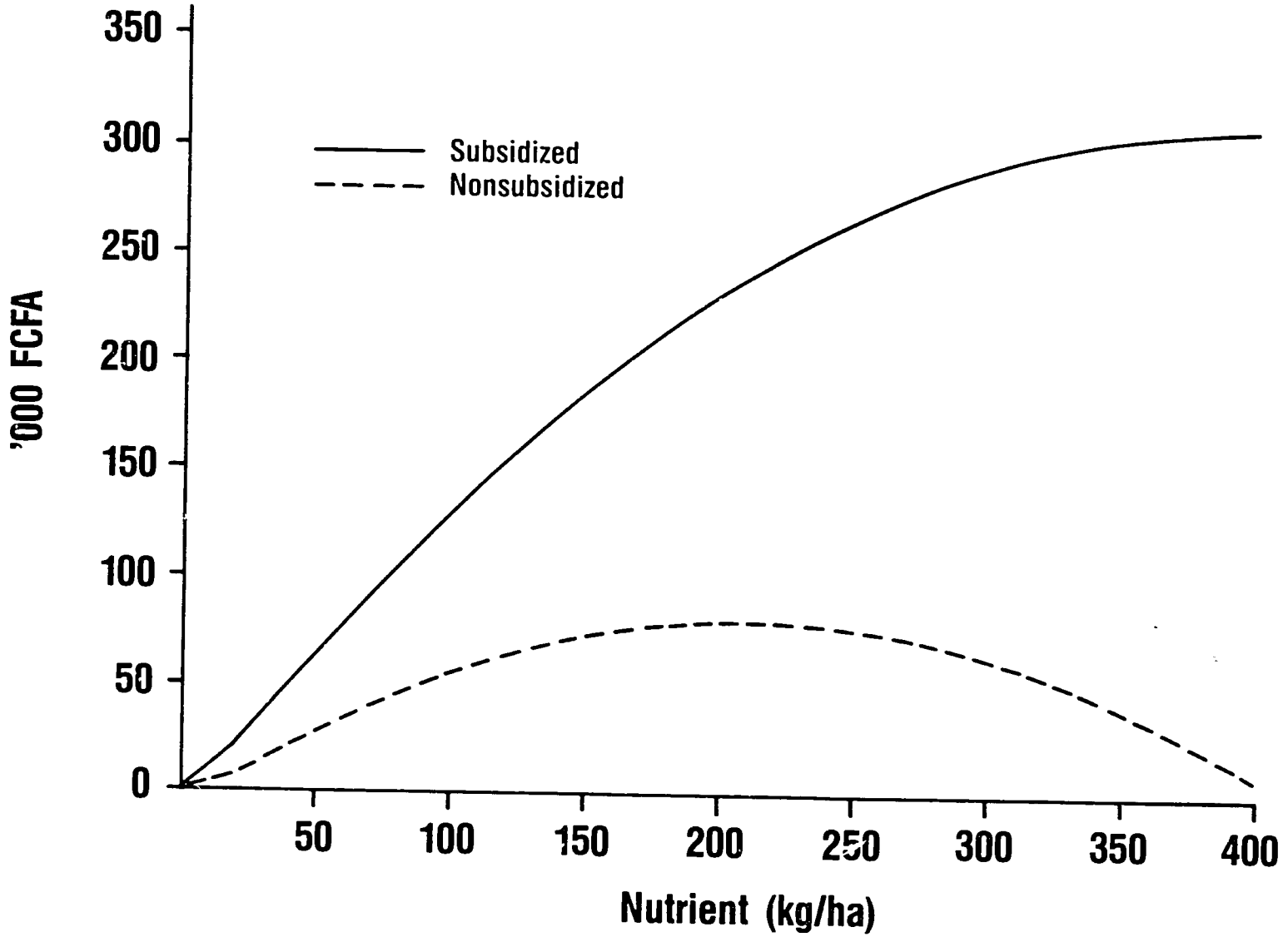


Figure I-8. Profit Per Hectare From Use of Fertilizer on Arabica Coffee Foumbot (Catura).

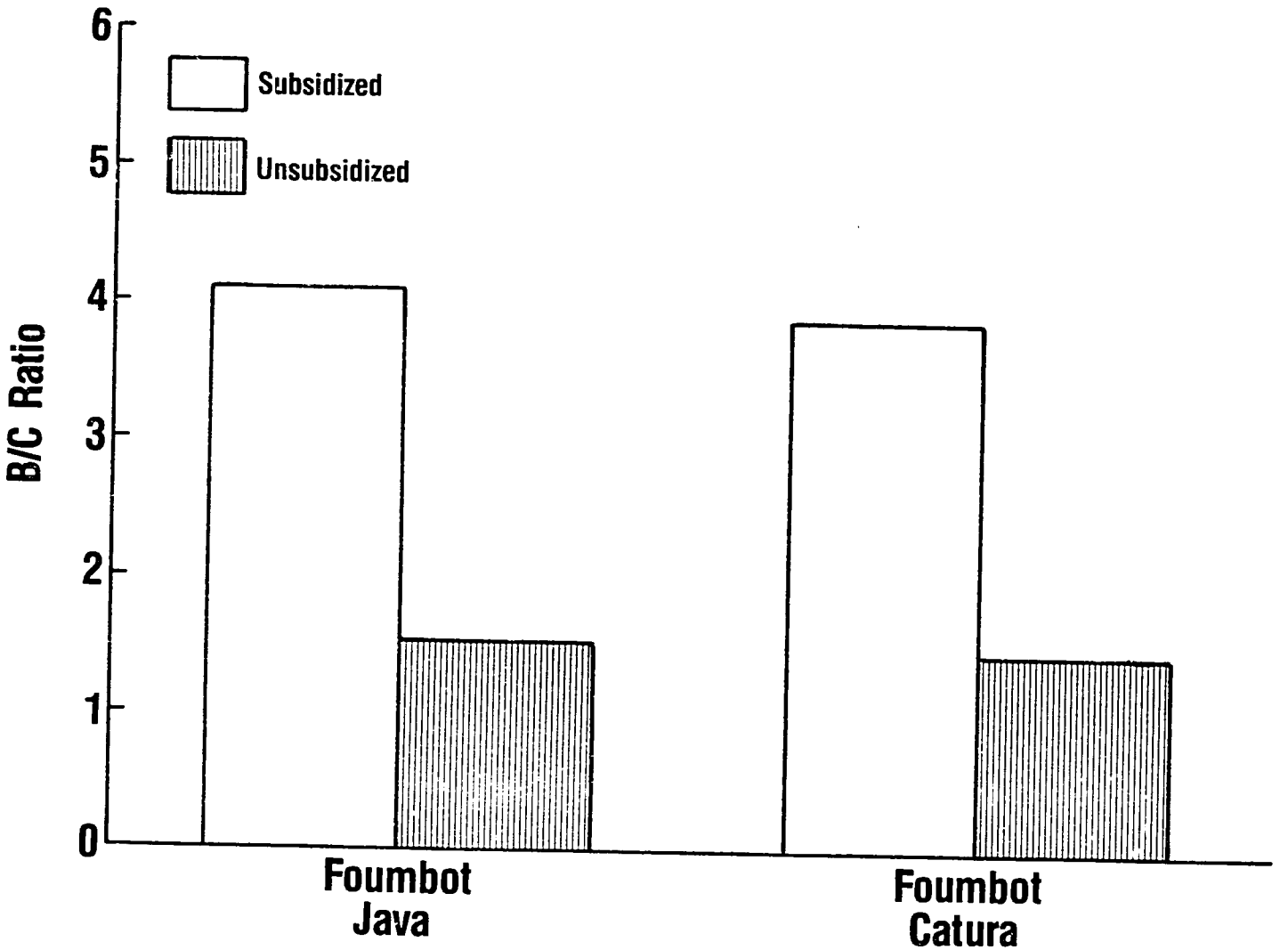


Figure I-9. Arabica Coffee Benefit/Cost Ratios With 200 kg/ha 20-10-10.

Table I-33 shows that returns from producing Arabica coffee are marginal. However, if the two trials shown in Table I-34 are representative then this indicates more money can be made (or conversely less money will be lost) if relatively high levels of fertilizer are used.

Robusta Coffee

The area planted to Robusta coffee is much larger than the area planted to Arabica coffee, and total production and yields are considerably higher. The 1984 Census indicated that 152,800 ha of Robusta coffee was grown with an average yield of 885 kg/ha (Table I-36).

The Census of Agriculture indicates that, although Arabica coffee is grown only in the West and North West Provinces, no province predominates in the area of Robusta coffee grown (Table I-37). Four provinces each contain 17%-24% of the total hectares. Although the Littoral Province does not have the largest area, it has the highest production because yields are very high (1,321 kg/ha). The West, South East, and East Provinces also have large areas of Robusta coffee.

Prices of Robusta coffee are lower than that of Arabica (Tables I-31 and I-38). However, gross income per hectare based on Census 1984 average yields and average prices for Robusta are more than double that of Arabica (FCFA 292,500 versus FCFA 117,600). Data supplied by UCCAO indicate that while production costs are higher for Robusta they are only about 20% higher (Table I-39). Thus it appears that the production of Robusta is more profitable than Arabica production. This may explain why the Ministry of Agriculture figures show areas of Arabica coffee declining while the area of Robusta is increasing.

Three trials have been run by IRA on the Robusta yield response to fertilizer as described earlier in the agronomic section. The trials measured only N response; phosphate and potash were used in the trials, and the response to N was isolated. The value of fertilizer use was summarized by using partial budgeting techniques. With the use of regression analysis and the research data from the three trials, the following equations were developed to estimate crop response:

1. $Y = 1{,}344 + 3.0\ N - .00458\ N^2$ $R^2 = .99$ (Barombi Kang 4-year average)
2. $Y = 801 + 2.76\ N - .0048\ N^2$ $R^2 = .93$ (Barombi Kang first year after cutback)
3. $Y = 1{,}132 + 2.15\ N - .0032\ N^2$ $R^2 = .99$ (Abong Mbang 10-year average)

Table I-36 Cameroon: Comparison of Robusta Coffee Statistics

Item	1978/79	1979/80	1980/81	1981/82	1982/83	Census 1984
Production ('000 mt)	81	73	87	84	105	119
Area ('000 ha)	198	200	208	215	221	153
Yield (kg/ha)	409	365	418	391	476	885

Source: Ministry of Agriculture, "Yearbook of Agricultural Statistics, 1982/83" and 1984 Agricultural Census.

Table I-37. Cameroon: Robusta Coffee Production by Province

Province	Hectares	Percent Area	Production (mt)	Yield (kg/ha)
Extreme North	-	-	-	-
North	-	-	-	-
Adamaoua	4,300	3	5,780	1,445
East	26,400	17	22,810	1,119
Central	12,000	8	7,540	699
South	700	-	210	341
Littoral	31,000	20	37,420	1,321
South West	36,400	24	12,900	387
North West	8,600	6	4,870	726
West	33,400	22	27,300	706
Cameroon	152,800	100	118,830	885

Source: 1984 Census of Agriculture.

Table I-38. Prices of Robusta Coffee

Year	Producer Price	f.o.b. Price	Percent	Year	Producer Price	f.o.b. Price	Percent
	- - (FCFA/kg)- - -				- - (FCFA/kg)- - -		
1961	96	142	64	1973	130	256	51
1962	90	142	63	1974	135	261	52
1963	102	155	66	1975	145	404	36
1964	127	149	85	1976	195	819	23
1965	100	115	69	1977	250	1,276	20
1966	115	160	72	1978	280	812	34
1967	115	166	69	1979	310	761	40
1968	115	156	74	1980	320	744	49
1969	117	197	59	1981	330	575	57
1970	125	204	61	1982	350	728	48
1971	125	208	60	1983	390	1,017	38
1972	125	209	60	1984	410	1,270	32

NOTE: Coffee prices are announced in January.

Source: "Bilan Diagnostic" as reported in "Cocoa in Cameroon, Policy and the Economics of Production," Volume I, page 54, Gagne-Gervais, "Cameroon the Cash Crop Sector: Its Performance and Future Development Possibilities," page 11, and Ministry of Agriculture Statistics.

Table I-39. Annual Cost of Producing Robusta Coffee

Activity	FCFA/ha
Establishment cost	9,000
Equipment cost	19,500
Clearing	60,000
Pruning (1,000 at FCFA 13 x 2)	26,000
Fertilizer (8 bags at FCFA 2,100)	16,800
Application (1,000 at 5 f x 2 times)	10,000
Insecticide	1,200
Renting sprayer	2,400
Labor for spraying (2 at FCFA 600)	1,200
Harvesting cost	18,400
Transporting cost	7,300
Drying cost	3,500
Transporting to the factory	9,000
Handling at the factory	2,500
Total Annual Cost/Hectare	186,800

Cost/kg with yield of 650 kg/ha = FCFA 287
Cost/kg with yield of 885 kg/ha = FCFA 211

Note: Same basic total establishment cost as for Arabica coffee but amortized over 30 years.

Source: D. Moreau, Directeur of Production, UCCAO, December 1983.

where

Y = Robusta yield in kg/ha

N = kg of N/ha

It was assumed that fertilizer is applied twice at a cost of 4 workdays/ application at FCFA 1,000/day. Costs of transporting fertilizer and extra output were estimated to be FCFA 2,000 .

Results of the trials are summarized in Table I-40 using both subsidized fertilizer (FCFA 200/kg N) and unsubsidized fertilizer (FCFA 952/kg N). Fertilizer recommendations for most of the Robusta coffee are 600 kg of 20-10-10. Crop value was determined by using the 1984 Census average price received for Robusta coffee (FCFA 330 rather than the official price of FCFA 410).

Table I-40 and Figure I-10 indicate that fertilization is profitable with subsidized fertilizer but unprofitable if nonsubsidized fertilizer has to be used with current prices assumed. The same is true even if farmers received the full FCFA 410/kg of Robusta coffee. Table I-41 indicates that Robusta coffee producers would have to be paid higher prices than they are now receiving before use of unsubsidized fertilizer would be profitable. However, additional profit from the use of subsidized fertilizer can be made with higher application rates.

Since these are research results with higher than average management, the farmer's results may be even less favorable. These results were also based on monocropping, and results with intercropping may not be as favorable. Again these rates tell us nothing about the profitability of growing Robusta coffee but indicate only that using subsidized fertilizer is profitable. However, the UCCAO budgets shown earlier for Robusta coffee indicate that production is profitable at yield levels indicated by the 1984 Census of Agriculture.

Cocoa

Cocoa is a major export crop in Cameroon. There is a substantial difference between hectares and yields shown by the Census and those shown by the historical Agricultural Statistics (Table I-42). Production figures between the two sources are somewhat consistent. The Minister of Trade and Industry recently reported that as of August 31, 1985, production for the 1984/85 seasons totaled 120,000 mt up from 108,000 in the previous season. Exports totaled 130,200 mt for Grades 1 and 2 beans in 1984/85 compared with 90,000 mt in 1984/85.

Table I-40. Robusta Coffee Net Returns and Benefit/Cost Ratios Using Recommended Fertilization Rate of 600 kg 20-10-10/ha

Trial	Location	Net Returns From Applying Fertilizer: Subsidized[a]	Net Returns From Applying Fertilizer: Unsubsidized[b]	Benefit/Cost Ratio: Subsidized	Benefit/Cost Ratio: Unsubsidized
		- - - - -(FCFA/ha)- - - - -			
1	Barombi Kang I	63,020	-27,220	2.85	.78
2	Barombi Kang II	52,460	-37,780	2.54	.70
3	Abong Mbang	35,960	-54,280	2.06	.56

a. 20-10-10 price: FCFA 40,000/mt (FCFA 200/kg N).
b. 20-10-10 price: FCFA 190,500/mt (FCFA 952/kg N).

Source: Based on response curves developed by IFDC from IRA research data. Coffee prices are average prices received as indicated in the 1984 Census of Agriculture, subsidized fertilizer prices are official prices outside Douala, unsubsidized prices are based on IFDC estimates.

Table I-41. Benefit/Cost Ratio Assuming Robusta Coffee Price at 410 FCFA/kg

Trial	Location	Yield (kg/ha)	Benefit/Cost Ratio: Subsidized[a]	Benefit/Cost Ratio: Unsubsidized[b]	Coffee Price Where Unsubsidized Fertilizer Becomes Profitable (FCFA/kg)
1	Barombi Kang I	1,638	3.55	0.97	412
2	Barombi Kang II	1,063	3.16	.86	426
3	Abong Mbang	1,344	2.56	.70	438

a. 20-10-10 price: FCFA 40,000/mt (FCFA 200/kg N).
b. 20-10-10 price: FCFA 190,500/mt (FCFA 952/kg N).

Source: Same as Table I-40 except coffee prices are official prices shown in Table I-38.

Table I-42. Cameroon: Comparison of Cocoa Figures

Item	1978/79	1979/80	1980/81	1981/82	1982/83	Census 1984
Production ('000 mt)	111	123	117	118	105	114
Area ('000 ha)	425	429	444	426	408	276
Yield (kg/ha)	261	287	264	278	258	381

Source: Ministry of Agriculture, "Yearbook of Agricultural Statistics, 1982/83," and 1984 Census of Agriculture.

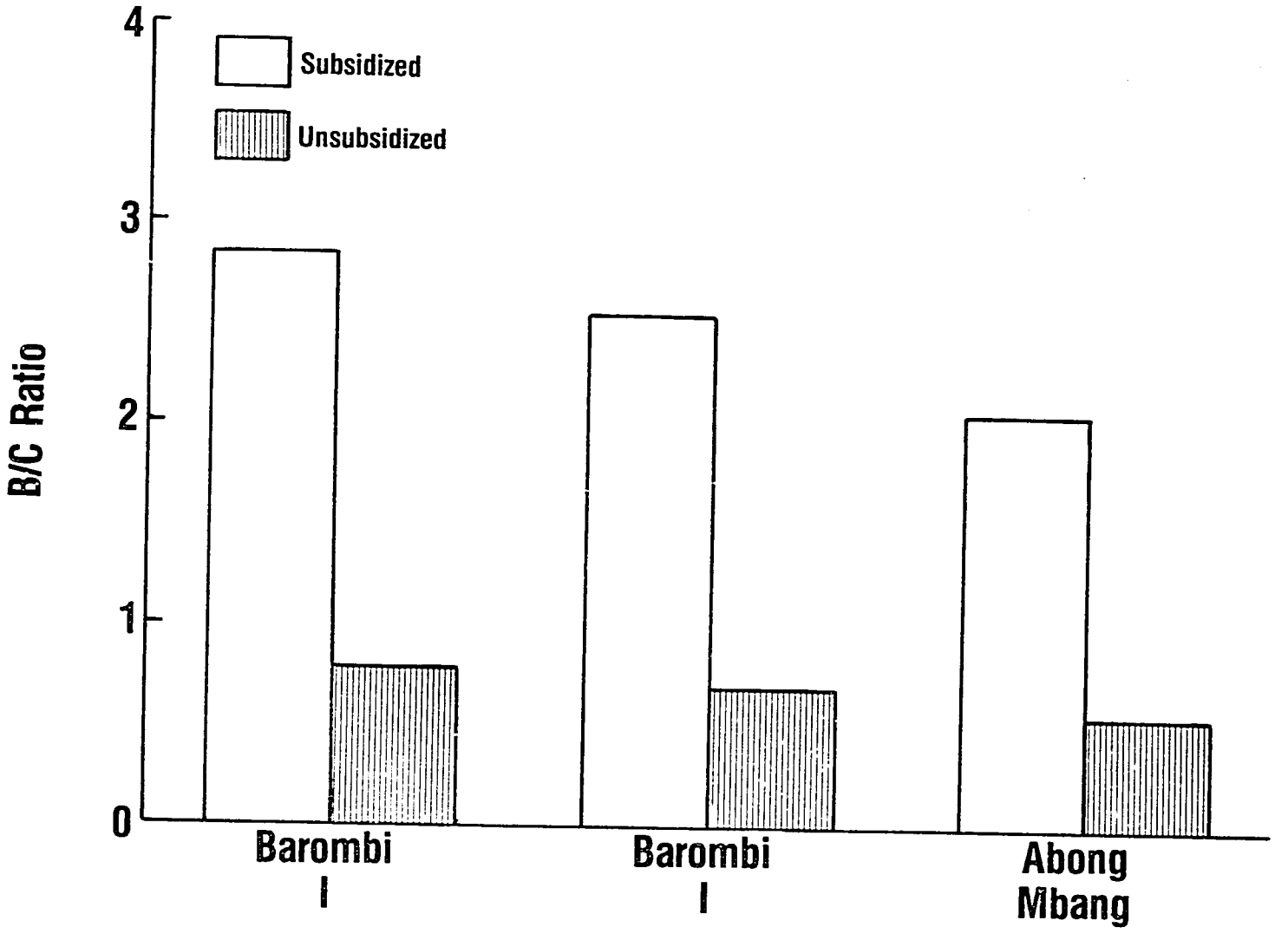


Figure I-10. Robusta Coffee Benefit/Cost Ratios With 600 kg/ha 20-10-10.

Cocoa prices are kept low by the ONCPB in order to "stabilize prices" by sheltering the cocoa farmer from erratic world prices and to keep the Cameroon cocoa producer from overplanting when world prices are high (Table I-43). Supply and demand price elasticities are low for cocoa. Since demand elasticity is low, an event such as a frost in Brazil can cause prices to go up substantially and stay high for more than 1 year. Thus, high prices could stimulate overplanting, and world markets would be flooded with cocoa 4-6 years later. With excess supplies and inelastic demand, competition among producers to sell cocoa would prompt cocoa prices to fall dramatically. Then no planting would be done, and the process would be repeated.

The government is providing grants of FCFA 200,000 (US $500) for each hectare of new plantation established and FCFA 100,000 for each hectare rehabilitated. Costs of producing cocoa are shown in Table I-44.

However, the policy of earning foreign exchange at the expense of the farmer makes it unprofitable to use fertilizer. We visited no one who indicated that fertilization of cocoa was profitable. However, the 1984 Census of Agriculture indicated that 13,400 cocoa producers applied fertilizer. Although this is less than 5% of the cocoa growers, it does indicate that under some conditions fertilization of cocoa must be profitable or these 5% would not be doing it.

Maize

Maize is the major food crop produced in Cameroon. There can be two plantings of maize per year. The Census indicates that about 89% of the maize area is planted in the first planting (Table I-45). Only a small percentage of the maize is fertilized. Maize uses an estimated 15% of all fertilizer consumed in Cameroon. The maize area averaged only 0.3 ha/farm. Only about 23% of the maize is sold by the farmer. The government indicated in the fifth 5-year plan that increasing food-crop production was to be a major objective. The Africa Economic Digest reported in October 1985 that the top priority of the sixth 5-year plan beginning on July 1, 1986, "remains rural development, with a target of food self-sufficiency and an eventual surplus of food production for export."

It should be pointed out that these census figures sharply disagree with trends that have been indicated by the "Yearbook of Agricultural Statistics" published by the Ministry of Agriculture (Table I-46). The figures for production seem consistent, but those for area are half the previous figures while those for yields are doubled. The large differences in areas are shown across all provinces. However, yields published previously seem unbelievably low.

Table I-43. Prices of Cocoa

Year	Producer Price	f.o.b. Price	Percent	Year	Producer Price	f.o.b. Price	Percent
	- - -(FCFA/kg) - -				- - - (FCFA/kg)- - -		
1961	75	104	72	1974	100	277	36
1962	70	113	62	1975	120	236	51
1963	72	117	62	1976	150	303	50
1964	80	90	89	1977	220	527	42
1965	45	97	46	1978	260	680	38
1966	55	127	43	1979	290	637	46
1967	55	153	36	1980	300	493	61
1968	70	201	35	1981	310	635	49
1969	85	196	43	1982	330	640	52
1970	85	144	59	1983	330	612	60
1971	75	128	59	1984	440[a]	754	58
1972	75	224	34	1985	420	1,110[b]	38
1973	80	227	35				

a. Includes a bonus price of FCFA 30.
b. Preliminary.

Source: Bilan Diagnostic as reported in "Cocoa in Cameroon, Policy and the Economics of Production," Volume I, 1983, page 54.

Table I-44. Present Costs of Production of Cocoa

Item	Farmer Costs		Total Costs	
	FCFA/ha	FCFA/kg	FCFA/ha	FCFA/kg
Return on investment	29,507	127	29,507	127
Amortization	7,025	30	7,025	30
Land	-	-	-	-
Fixed costs	36,532	157	36,532	157
Labor	40,500	174	40,500	174
Family	30,000	129	30,000	129
Exchange	7,500	32	7,500	32
Hired	3,000	13	3,000	13
Tools and equipment	6,344	27	6,344	27
Pesticides	-	-	7,968	34
Marketing (f.o.b. Douala)	-	-	13,747	59
Variable Costs	46,844	201	68,559	294
TOTAL COSTS	83,376	358	105,091	451

Source: "Cocoa in Cameroon, Policy and the Economics of Production," Volume II, page 126.

Table I-45. Cameroon: Maize Areas, Yields and Production, 1984

Province	Area Planted 1st	Area Planted 2nd	Total	Total Production	Yield	Percent of Maize Farmers Fertilizing[a]
	- ('000 ha)-		('000 ha)	('000 mt)	(kg/ha)	
Extreme North	10.2	-	10.2	6,790	665	-
North	10.6	-	10.6	13,110	1,239	-
Adamaoua	23.8	0.1	23.9	43,310	1,811	-
East	8.5	4.7	13.1	25,420	2,012	10
Central	6.6	5.1	11.6	15,440	1,327	2
South	1.7	0.9	2.6	3,810	1,455	0
Littoral	6.1	0.9	7.0	6,900	983	10
South West	5.1	2.0	7.1	11,210	1,581	16
North West	54.4	5.5	60.0	168,990	2,820	19
West	55.7	3.9	59.6	112,760	1,894	34
	182.7	23.0	205.7	408,740	1,987	

a. Statistics given for number of food-crop farmers using fertilizer and total number of maize farmers. Calculation made by assuming all food-grain farmers are maize farmers. This is not true in the northern provinces.

Source: Derived from 1984 Census of Agriculture.

Table I-46. Cameroon: Comparison of Maize Figures

	1978/79	1979/80	1980/81	1981/82	1982/83	Census 1984
Production ('000 mt)	401	408	411	425	491	400
Area ('000 ha)	537	545	496	439	454	206
Yield (kg/ha)	747	748	828	968	1,081	1,987

Source: 1978/79 to 1982/83 from Ministry of Agriculture "Yearbook of Agricultural Statistics."

Table I-47. Partial Budget for Maize

	Without Fertilizer	With Fertilizer
Average yield (kg/ha)	2,331	4,980
Returns at FCFA 60/kg (FCFA/ha)	139,920	298,800
Variable cost		
600 kg 20-10-10/ha at FCFA 40/kg	0	24,000
Labor at FCFA 900/day[a] (FCFA/ha)	0	3,600
Net returns[b] (FCFA/ha)	139,920	271,200

a. Four workdays/ha for fertilizer application.
b. Benefit/cost ratio = 158,880/27,600 = 5.8

Source: IRA.

Maize is generally intercropped with other crops. Studies in the North West Province, which has the largest area of maize, indicate that 95% of the maize is grown with other crops although maize is the prime recipient of the fertilizer which is applied to food crops.

Reports of applying fertilizer to coffee for the benefit of maize are widespread. However, in the North West Province only an estimated 7% of the maize is intercropped with coffee, and in the West Province, the other large maize area, only an estimated 30% of the maize is intercropped with coffee. Thus the area of maize that benefits from the fertilization of coffee is somewhat limited.

The Testing and Liaison Unit of IRA (TLU) conducted a study (reported in their 1983 Annual Report) to determine the optimum level and timing of application of 20-10-10 compound fertilizer to maize. This is the only complete fertilizer readily available to farmers.

A partial budget analysis of 12 treatment rates was carried out. The optimal fertilizer rate was 600 kg of 20-10-10 per hectare, all applied at planting. A partial budget analysis of this rate of application is shown in Table I-47.

The IRA "COCA" variety showed a net benefit per hectare for the farmer who switches from the production of the local variety without fertilizer to the production of COCA using a moderate fertilizer rate. The report stated that 63% of this increase can be attributed to the influence of fertilizer on the performance of the improved variety. All fertilizer plots outyielded the unfertilized plots of the same variety including local varieties.

A MIDENO study ("Extension Service Survey 1984/85" May 1985, Planning Evaluation and Monitoring Division) of 120 farmers who applied fertilizer to both improved and local varieties of maize and 60 who planted local maize and did not use fertilizer indicated that farmers who applied fertilizer to improved maize achieved yields of 1.71 mt/ha and farmers who applied fertilizer to local varieties of maize achieved yields of 1.32 mt/ha. According to the study, "a majority of the farmers who did not use fertilizer claimed that they did not use fertilizer due to an absence of money, but a few of them still had a notion that fertilizer was unnecessary."

Another report (MIDENO, 1983) states that although only 12.5% of 161 farmers surveyed used fertilizer on maize "the yield difference was very marked, and was highly significant at the 99% level." However, a comparison of yields was not presented. The report does state that the TLU 1982 farmer field trials reported a 35% increase in yields from fertilizer on local maize.

The 1984 Annual Report of the Farming Systems Program describes mixed crop-maize variety trials in the North West and West Provinces. Fertilizer (20-10-10) was applied at 250 kg/ha as a single dose at planting. The same variety of beans was grown at the same seeding rate on all plots. Partial budgets were developed to determine the net benefits from the additional use of fertilizer. In some trials groundnuts were intercropped with maize. In general, fertilizer applied to maize-beans was quite profitable, whereas the profitability of fertilizing maize-groundnuts was not conclusive. However, fertilization of local maize varieties in most cases was very profitable. Trials in various areas are described below.

1. Eastern Highlands (NWP)--The local variety with no fertilizer outperformed all varieties with or without fertilizer. The average yield was only slightly higher with fertilizer (22 kg/ha) although beans responded positively and significantly to the moderate fertilizer rate (average difference of 125 kg/ha). The report indicated that little work has been done on improved maize varieties in the high-altitude zone.
2. Ndop Plain (NWP)--The fertilizer effect on maize was significant at the 1% level, and variety of maize was less significant. Yields were 72% higher with fertilizer than without fertilizer on the five varieties (1.76 versus 1.02). Fertilizer even improved yields on the local varieties by 52%. Beans were not affected by maize variety, but beans showed a positive response to fertilizer (39%). Net benefits from using fertilizer were increased on all varieties by an average of 37% (FCFA 91,865 versus FCFA 67,012).
3. Bamenda Plain (NWP)--Maize and groundnuts were grown together. Fertilized maize resulted in shading the groundnuts and decreased groundnut yields although the reduction was not statistically significant. Groundnut prices were eight times maize prices; thus, variations in groundnut production had a major effect on the economics. The most profitable situation tested did not use fertilizer although there were only minor differences in total net returns of both crops with and without fertilizer.
4. Western High Plateau (WP)--Fertilized soils resulted in high maize yields, but shading from fertilizer use again reduced groundnut yields. The effect of using fertilizer was not statistically significant. The report still indicated that the marginal rate of return[2] from using fertilizer on local varieties was 16%.

2. Additional net benefit divided by additional variable cost.

5. Menchum Valley (NWP)--This was a low-altitude treatment including maize and groundnuts. There was not a significant response by fertilizer or by variety with fertilizer. Groundnut yields were also not significantly different. Using fertilizer on local varieties gave a marginal rate of return of 35%.

Response curves were developed in the agronomic portion of this report using data generated by IRA in recent research trials. Equations developed by IFDC from these data are as follows:

1. $Y = 2{,}398 + 24.24\ N - .081\ N^2 + 10.57\ P$ (Sanguere) $R^2 = .84$
2. $Y = 2{,}709 + 47.18\ N - .177\ N^2$ (Touboro) $R^2 = .96$
3. $Y = 3{,}545 + 46.7\ N - .183\ N^2 + 5.84\ P$ (Tchollire) $R^2 = .94$
4. $Y = 3{,}325 + 36.04\ N - .170\ N^2$ (Fignole) $R^2 = .80$

where

Y = Maize yield in kg/ha

N = kg of N/ha

P = kg of P_2O_5/ha

All four of these trials were conducted in the North following cotton. Partial budgeting was used to estimate the benefits of using fertilizer and the associated costs. Benefit/cost ratios were also calculated. A comparison of the different types of fertilizer was also made. Subsidized fertilizer was priced at FCFA 120/kg as now charged by SODECOTON. Concessional fertilizer was based on prices shown in Section II in Table II-5. Value of the maize was priced at FCFA 89/kg, the average selling price in Cameroon in 1984 as indicated by the Census. Average prices in the three northern provinces ranged from FCFA 79/kg to FCFA 130/kg. Application rates used are those of SODECOTON which recommends two bags of compound and two bags of urea sidedressed later.

The data indicate that fertilizer use on maize is very profitable even if it is not subsidized. Benefit/cost ratios were at least 2.50 in all the trials analyzed (Table I-48). The average B/C ratio using unsubsidized fertilizer over all trials is shown in Figure I-11; it shows no significant difference in profitability among the fertilizers analyzed. Small changes in prices could make one fertilizer superior.

Unfortunately the data are from yields that are higher than farmer averages. However, this is an improved variety and researchers indicate that these yields and results could be duplicated by farmers although it should be noted that the B/C ratios are very high.

Table I-48. Net Returns and Benefit/Cost Ratios of Maize to N, P, and K After Cotton With an Additional 100 kg of Urea Sidedressed to All Applications

Trial	Recommended Use[a]	Price		Yield at Recommended Rate	Net Returns From Fertilizer		Benefit/Cost Ratio	
		Subsidized	Unsubsidized		Subsidized	Unsubsidized	Subsidized	Unsubsidized
		- -(FCFA/product kg) - -		(kg/ha)	- - - - (FCFA/ha)- - - -			
Sanguere								
DAP	100	120	230	4,104	117,874	100,274	4.47	2.94
10-30-10	100	120	190	3,819	92,476	78,876	3.72	2.66
15-15-15	100	120	204	3,734	84,940	69,940	3.50	2.43
20-10-10	100	120	191	3,751	86,449	72,849	3.54	2.53
22-10-15	100	120	207	3,778	88,834	73,634	3.61	2.50
Touboro								
DAP	100	120	230	5,004	170,213	152,613	6.01	3.96
10-30-10	100	120	190	4,796	151,744	138,144	5.46	3.90
15-15-15	100	120	204	4,928	163,523	148,523	5.81	4.03
20-10-10	100	120	191	5,052	174,515	160,915	6.13	4.38
22-10-15	100	120	207	5,099	178,691	163,491	6.26	4.31
Tchollire								
DAP	100	120	230	6,053	189,201	171,601	6.56	4.33
10-30-10	100	120	190	5,762	163,270	149,670	5.80	4.14
15-15-15	100	120	204	5,800	166,727	151,727	5.90	4.10
20-10-10	100	120	191	5,888	174,567	160,967	6.13	4.38
22-10-15	100	120	207	5,933	178,515	163,597	6.24	4.31
Fignole								
DAP	100	120	230	4,935	109,311	87,311	4.22	2.56
10-30-10	100	120	190	4,810	98,176	84,176	3.89	2.75
15-15-15	100	120	204	4,891	105,362	88,562	4.10	2.74
20-10-10	100	120	191	4,963	111,793	97,593	4.29	3.02
22-10-15	100	120	207	4,990	114,153	96,753	4.36	2.88

a. This application plus 100 kg urea/ha.

Note: Fertilizer in the north is sold for FCFA 120,000/mt by SODECOTON. The fertilizer receives no subsidy from FONADAR but is subsidized by SODECOTON.

Source: Based on response curves developed by IFDC from IRA research data. Maize prices are the average selling price in Cameroon as reported in 1984 Census of Agriculture. Nonsubsidized fertilizer prices were estimated by IFDC.

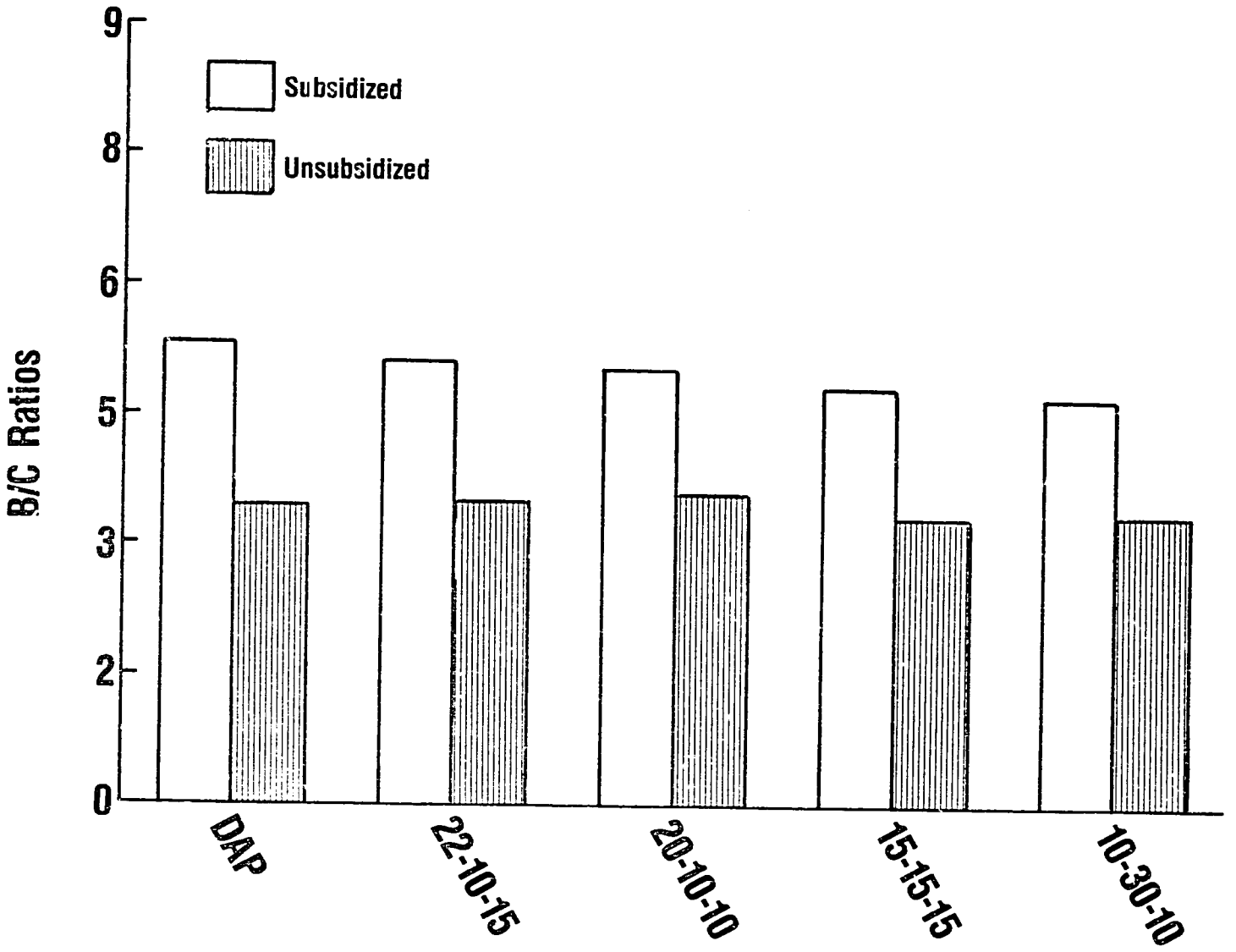


Figure I-11. Maize Benefit/Cost Ratios After Cotton With 100 kg Compound Plus 100 kg Urea.

One of the problems in doing an economic analysis such as this is selecting the actual crop price and fertilizer price to use in the analysis. In this study we used a maize price of FCFA 89/kg. This was the average price received by all Cameroon farmers in 1984 as indicated by the Census of Agriculture. However, Census statistics indicate that this price varied from a high of FCFA 143/kg in the South Province to a low of only FCFA 62/kg in the West. Undoubtedly variation within the provinces and in various months was even greater. We have selected the Touboro Province and done a sensitivity test on how the B/C ratio would be affected at various maize prices ranging from FCFA 30/kg to FCFA 140/kg (Table I-49). Prices used were the SODECOTON concessionary price of FCFA 120,000/mt, and the unsubsidized fertilizer price of FCFA 188,000/mt. Fertilizer use was profitable at all prices within this range regardless of whether it was subsidized or not subsidized.

Similiar response curves were developed that would be applicable for the West, South West, and North West. Table I-16 gives response curves obtained using data from IRA research trials which included different levels of fertilizer application.

The following equations were developed:

Ekona	$Y = 6{,}045 + 32.11\ N - 0.144\ N^2 + 13.33\ P$	$R^2 = .83$
Ntui	$Y = 5{,}637 + 3.78\ N - 7.78\ P$	$R^2 = .68$
Mbam Mboum	$Y = 1{,}898 + 11.70\ P - 0.039\ P^2 + .068\ NP$	$R^2 = .83$
Yaounde	$Y = 3{,}504 + 29.82\ N - 0.066\ N^2 + 49.22\ P - 0.463\ P^2 - 0.116\ NP$	$R^2 = .91$

where

Y = kg of maize/ha

N = kg of N/ha

P = kg of P_2O_5/ha

Partial budgeting was used to estimate the benefits of using fertilizer and the associated costs. Benefit/cost ratios were also calculated. A comparison of the different types of fertilizer was also made. These were not based on field trials but by calculating the yields that would be attained from the nutrients contained in each fertilizer using the above equations. Fertilizer was priced at the subsidized rate of price FCFA 40/kg as now charged to all farmers in these areas by FONADER. The maize was valued at FCFA 89/kg, the average selling price in 1984 in Cameroon. The recommended application of 250 kg of each fertilizer was used since the total purchase price would be the

Table I-49. Benefit/Cost Ratios From Using 100 kg 10-30-10 Sidedressed With 100 kg Urea at Various Crop Prices on Maize Based on Research Trials Conducted at Touboro

Maize Price (FCFA/kg)	Benefit/Cost Ratios Subsidized[a]	Benefit/Cost Ratios Unsubsidized[b]
30	1.84	1.17
40	2.46	1.56
50	3.07	1.95
60	3.68	2.34
70	4.30	2.73
80	4.91	3.11
90	5.52	3.50
100	6.14	3.89
110	6.75	4.28
120	7.37	4.67
130	7.98	5.06
140	8.59	5.45

a. FCFA 120,000/mt.
b. FCFA 188,000/mt.

Source: Based on response curves derived by IFDC from IRA research data. Subsidized fertilizer prices based on SODECOTON price. Unsubsidized prices based on IFDC estimates.

same. Since 10-30-10 is low in nitrogen, calculations were also made using 150 kg of this fertilizer and sidedressing with 100 kg of urea.

The data indicate that DAP (18-46-0) was the superior fertilizer in the first three trials and had high B/C ratios in the Yaounde trials although these were reached at less than 250 kg/ha (Table I-50). Figure I-12 illustrates the average B/C ratio obtained in the four trials using subsidized fertilizer. This emphasizes the need for a high-phosphate fertilizer for this area.

Because of this phosphate need, ammonium sulfate, which is the most readily available fertilizer in the west, ranked last in benefit/cost ratios. In the Ntui trial it was not profitable to use even when subsidized. The other available fertilizers containing potash (20-10-10 and 12-6-20) ranked relatively low because of a lack of potash response. The highest yields, highest returns from using fertilizer, and highest benefit/cost ratios based on the response curves from these particular experiments would have been obtained from a high-phosphate fertilizer such as DAP, TSP, or--where potash levels are of concern--10-30-10.

Again, one of the problems in doing an economic analysis such as this is selecting the actual crop price and fertilizer price to use. In this analysis we used FCFA 89/kg of maize because this was the average price received by all farmers in Cameroon in 1984. However, Census statistics indicate that this price varied from a high of FCFA 143/kg in the South Province to a low of only FCFA 62/kg in the West Province. Undoubtedly within the provinces the variation was even larger. We have selected the Mbam Mboum trial (toward the bottom of the four trials in fertilizer response) and have run a sensitivity test using maize prices from FCFA 30 to 140/kg and 10-30-10 sidedressed with 100 kg of urea. With subsidized fertilizer (FCFA 40,000/mt) the use of fertilizer on maize is profitable within this range of maize prices. However, if we use unsubsidized fertilizer (FCFA 188,000/mt), maize prices must be FCFA 90/kg before use of fertilizer is profitable (Table I-51).

Rice

The Census indicates that 19,200 ha of rice was grown on 34,700 farms in 1984 with an average yield of 2,626 kg/ha. The best average yields are in the three SEMRY locations in the North where production and fertilization are carefully managed.

Research by IRA was carried out at Vounaloum and Maga for both wet and dry rice and also at Kousseri for wet rice to determine the response of rice to

Table 1-50. Net Returns and Benefit/Cost Ratios of Maize at Ekona, Ntui, Mbam Mboum, and Yaounde

Trial	Use at Recommended Rate (kg/ha)	Fertilizer Price Subsidized (FCFA/kg)	Fertilizer Price Unsubsidized (FCFA/kg)	Yield at Recommended Rate (kg/ha)	Profit From Fertilizer Subsidized (FCFA/ha)	Profit From Fertilizer Unsubsidized (FCFA/ha)	Benefit/Cost Ratio Subsidized	Benefit/Cost Ratio Unsubsidized
Ekona								
0-46-0	250	40	204	7,578	116,433	75,433	6.82	2.24
10-30-10	250	40	190	7,839	139,622	102,122	7.98	2.78
10-30-10 and urea[a]	150 1[illegible]	40	188	8,657	212,481	175,481	11.62	4.08
12-6-20	2[illegible]0	40	204	7,195	82,376	41,376	5.12	1.68
15-15-15	[illegible]0	40	204	7,729	129,854	88,854	7.49	2.46
18-46-0	250	40	237	8,994	242,438	193,188	13.12	3.79
20-10-10	250	40	191	7,948	149,345	111,595	8.47	2.93
21-0-0	250	40	152	7,691	126,502	98,502	7.33	3.05
22-10-15	250	40	207	8,101	162,961	121,211	9.15	2.96
46-0-0	250	40	185	9,547	291,697	255,447	15.58	5.54
Ntui								
0-46-0	250	40	204	6,535	56,698	18,628	3.98	1.31
10-30-10	250	40	190	6,318	40,342	2,842	3.02	1.05
10-30-10 and urea[a]	150 100	40	188	6,221	31,681	-	2.58	-
12-6-20	250	40	204	5,870	479	-40,521	1.02	.34
15-15-15	250	40	204	6,074	18,582	-22,418	1.93	.63
18-46-0	250	40	230	6,705	74,767	27,267	4.74	1.40
20-10-10	250	40	191	6,024	14,132	-23,618	1.71	.59
21-0-0	250	40	152	5,838	-2,338	-30,338	.88	.37
22-10-15	250	40	207	6,042	15,814	-25,936	1.79	.58
46-0-0	250	40	185	6,075	18,688	-17,562	1.93	.69
Mbam Mboum								
0-46-0	250	40	204	2,728	53,846	12,846	3.69	1.21
10-30-10	250	40	190	2,684	49,921	12,421	3.50	1.22
10-30-10 and urea[a]	150 100	40	188	2,532	36,442	-558	2.82	.99
12-6-20	250	40	204	2,095	-2,438	-43,438	.88	.29
15-15-15	250	40	204	2,378	22,678	-18,322	2.13	.70
18-46-0	250	40	230	3,080	85,165	37,665	5.26	1.56
20-10-10	250	40	191	2,251	11,428	-26,322	1.57	.54
21-0-0	250	40	152	1,898	-20,000	-48,000	0	0
22-10-15	250	40	207	2,260	12,185	-29,565	1.61	.52
46-0-0	250	40	185	1,898	-20,000	-56,250	0	0
Yaounde								
0-46-0	250	40	204	3,041	b	b	b	b
10-30-10	250	40	190	5,078	120,075	82,575	7.00	2.44
10-30-10 and urea	150[b]	40	188	6,036	168,378	168,378	11.27	3.95
12-6-20	250	40	204	4,921	106,124	65,124	6.31	2.07
15-15-15	250	40	204	5,561	163,070	122,070	9.15	3.00
18-46-0	250	40	230	3,649	c	c	c	c
20-10-10	250	40	191	5,626	168,869	131,119	9.44	3.27
21-0-0	250	40	152	4,888	103,144	75,144	6.16	2.57
22-10-15	250	40	207	5,726	177,765	136,015	9.89	3.20
46-0-0	250	40	185	6,067	207,524	171,687	11.38	4.04

a. 150 kg 10-30-10 and 100 kg urea.

b. Unprofitable at this level of usage but B/C ratios of 8.2 and 4.1 were achieved at lower levels for subsidized and unsubsidized fertilizer, respectively.

c. Unprofitable at this level of usage but B/C ratios of 10.8 and 4.9 were achieved at lower levels for subsidized and unsubsidized fertilizer, respectively.

Source: Response curves derived from IRA data. Maize prices based on Cameroon average as reported in 1984 Census of Agriculture. Subsidized fertilizer prices based on official prices outside Douala. Unsubsidized prices based on IFDC estimates.

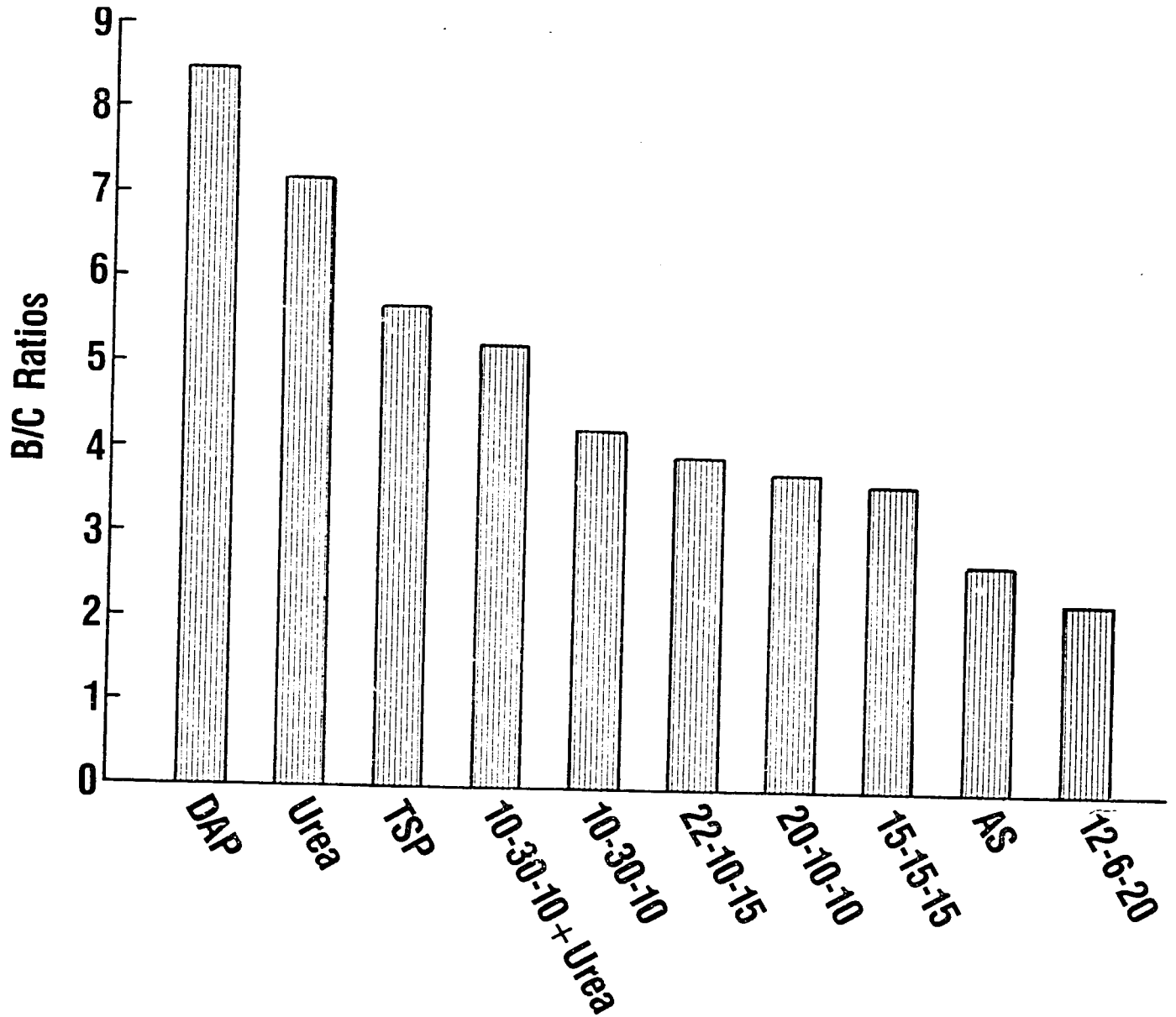


Figure I-12. Average of Ekona, Ntui, Mbam Mboum, and Yaounde (Maize Benefit/Cost Ratios With 250 kg/ha).

Table I-51. Benefit/Cost Ratio With Varying Maize Prices Obtained by Using 150 kg/ha of 10-30-10 and 100 kg/ha of Urea Based on IRA Trials at Mbam Mboum

Maize Prices (FCFA/kg)	Benefit/Cost Ratios Subsidized[a]	Benefit/Cost Ratios Unsubsidized[b]
30	0.95	0.33
40	1.27	.45
50	1.59	.56
60	1.90	.67
70	2.22	.78
80	2.54	.89
90	2.85	1.00
100	3.17	1.11
110	3.49	1.22
120	3.81	1.34
130	4.12	1.45
140	4.44	1.56

a. FCFA 40,000/mt.
b. FCFA 188,000/mt.

Source: Based on response curves developed by IFDC from IRA data. Subsidized fertilizer prices are official prices outside Douala. Unsubsidized fertilizer prices were estimated by IFDC.

nitrogen. The recommended fertilization for SEMRY irrigated rice is 90 kg of N applied as urea in three applications.

IFDC developed response curves based on the raw data from this research. The five curves were:

Vounaloum (dry)	$Y = 3.53 + .028\ N - .000066\ N^2$	$R^2 = .53$
Maga (dry)	$Y = 2.26 + 0.2\ N - .000048\ N^2$	$R^2 = .30$
Vounaloum (wet)	$Y = 3.28 + .029\ N - .000064\ N^2$	$R^2 = .59$
Maga (wet)	$Y = 3.16 + .029\ N - .000101\ N^2$	$R^2 = .86$
Kousseri (wet)	$Y = 4.02 + .028\ N - .000088\ N^2$	$R^2 = .68$

where

Y = rice yield in kg/ha

N = kg of N/ha

Net returns from using fertilizer were calculated on the basis of partial budgeting procedures and benefits and costs associated with fertilizer use. Calculations were made with both subsidized urea (FCFA 40,000/mt) and unsubsidized urea (assumed to be FCFA 185,000/mt). Rice prices used were FCFA 80/kg, the price indicated by the 1984 Census.

In all trials both subsidized and unsubsidized urea had positive net returns (Table I-52). All B/C ratios exceeded 2.86, indicating that it is very profitable to use urea (Figure I-13). However, all trials were done at high levels of yields on improved varieties.

Sorghum

The 1984 Census of Agriculture indicates that 365,400 farmers planted a total of 373,500 ha of grain sorghum/millet, almost double the maize area. Production totaled 207,660 mt, an average yield of 556 kg/ha.

IRA has conducted experiments on grain sorghum in the North. IFDC estimated response curves from these data. Three equations were fitted as follows:

Bere	$Y = 2{,}445 + 22.03\ N - .114\ N^2$	$R^2 = .93$
Sanguere	$Y = 2{,}950 + 30.12\ N - .210\ N^2 + 13.72\ P$	$R^2 = .62$
Touboro	$Y = 1{,}247 + 28.03\ N - .153\ N^2 + 10.11\ P + 5.99\ K - .121\ NP$	$R^2 = .86$

where

Y = Sorghum yields in kg/ha

N = kg of N/ha

P = kg of P_2O_5/ha

Table I-52. Response From Using Recommended Application of 90 kg of N on Irrigated Rice

Location	Yield (kg/ha)	Net Returns From Fertilizer (FCFA/ha) Subsidized	Net Returns From Fertilizer (FCFA/ha) Unsubsidized	Benefit/Cost Ratios Subsidized	Benefit/Cost Ratios Unsubsidized
Vounaloum dry	5,515	136,970	108,620	7.27	3.16
Maga dry	3,671	91,050	62,700	5.17	2.25
Vounaloum wet	5,372	145,530	117,180	7.67	3.34
Maga wet	4,952	121,530	93,180	6.57	2.86
Kousseri wet	5,827	122,730	94,380	6.62	2.88

Fertilizer subsidized price = FCFA 40,000/mt.
Fertilizer unsubsidized price = FCFA 185,000/mt.
Rice price = FCFA 80/kg.

Source: Response curves derived by IFDC based on IRA research data. Rice prices based on 1984 Census of Agriculture. Subsidized fertilizer prices based on price charged by SEMRY. Unsubsidized fertilizer prices based on IFDC estimates.

Table I-53. Response From Using 50 kg of Various Fertilizers on Sorghum
Price = 120 FCFA/kg product (SODECOTON price)

Location	Fertilizer Usage (kg/ha)	Yield (kg/ha)	Net Returns From Fertilizer (FCFA/ha)	Benefit/Cost Ratios
Bere				
10-30-10	50	2,552	-5,728	0.64
15-15-15	50	2,604	-736	.95
18-46-0	50	2,634	2,144	1.13
20-10-10	50	2,654	4,064	1.25
22-10-15	50	2,674	5,984	1.37
46-0-0	50	2,891	26,816	2.68
Sanguere				
10-30-10	50	3,293	16,928	2.06
15-15-15	50	3,259	13,664	1.85
18-46-0	50	3,496	36,416	3.28
20-10-10	50	3,289	16,544	2.03
22-10-15	50	3,313	18,848	2.18
46-0-0	50	3,505	37,280	3.33
Touboro				
10-30-10	50	1,556	13,644	1.85
15-15-15	50	1,563	14,336	1.90
18-46-0	50	1,694	26,912	2.68
20-10-10	50	1,586	16,544	2.03
22-10-15	50	1,626	20,384	2.27
46-0-0	50	1,811	38,144	3.38

Source: Response curves derived by IFDC based on IRA research data. Sorghum prices from 1984 Census of Agriculture. Fertilizer prices based on prices charged by SODECOTON (FCFA 120,000/mt).

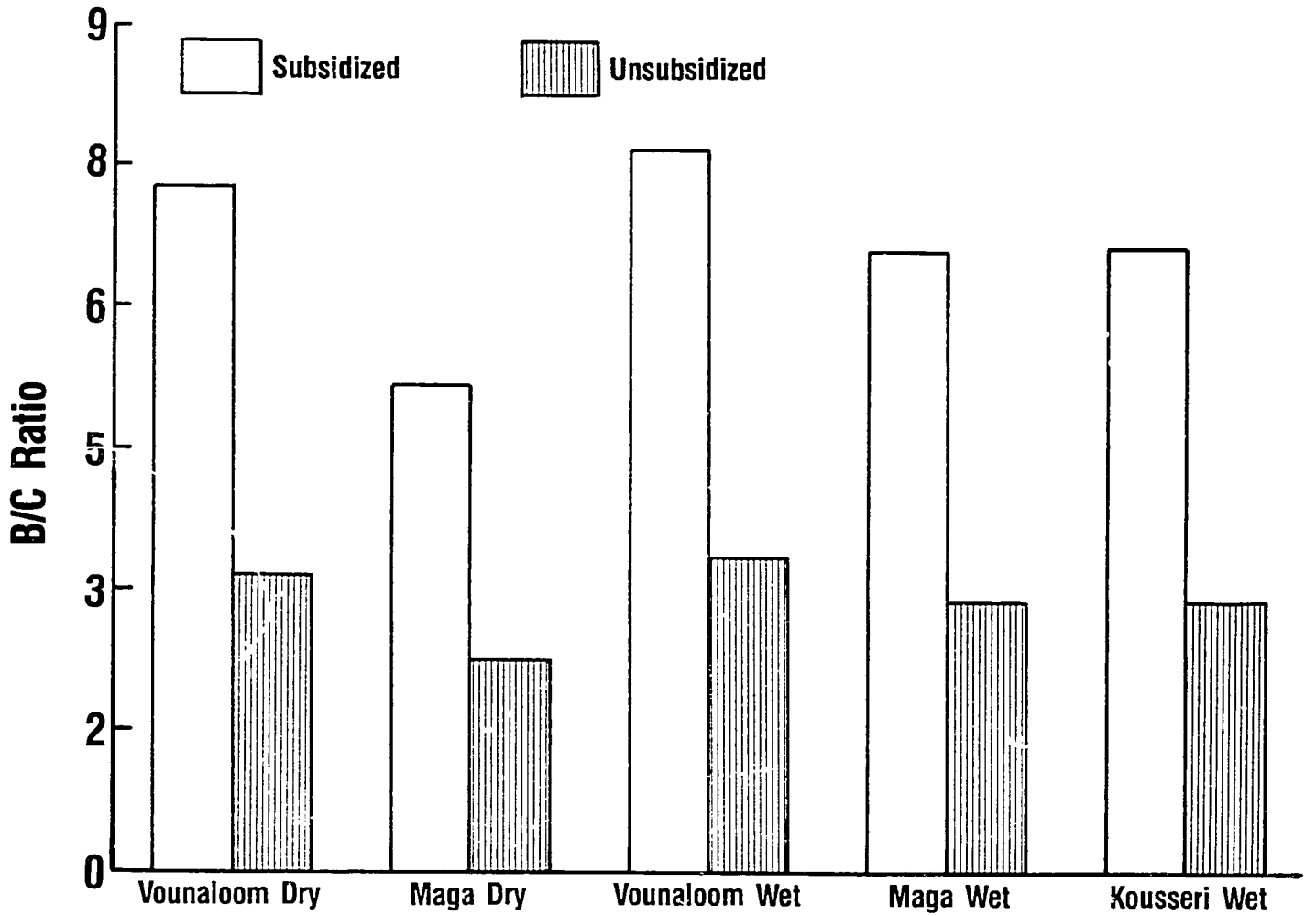


Figure I-13. Rice Benefit/Cost Ratios (90 kg/ha of Urea Applied 3 Times).

K = kg of K/ha

NP = kg of N/ha multiplied by kg P_2O_5/ha

It was assumed that, since farmers in the North who purchase their fertilizer from SODECOTON pay FCFA 120,000/mt for all fertilizers, the objective should be to buy the fertilizer which gives the highest net return from its use. Currently 50 kg/ha of urea is recommended. Sorghum prices of FCFA 96/kg were used, which the Census indicates was the average price received in 1984.

Table I-53 indicates that urea is the most cost effective fertilizer for sorghum. Although fertilization with some fertilizers was quite marginal, fertilization with urea in all three trials was quite profitable. The large sorghum area, which is mostly unfertilized now, indicates there may be a large potential in the North for urea. Although the trials were based on high yields in almost all cases, net returns could be increased by applying higher than 50 kg/ha.

Summary of Economics of Fertilizer Use

Arabica Coffee--Fertilization appears quite profitable with subsidized fertilizer in two trials presented. B/C ratios computed for the first two trials at recommended rates were 4.10 and 3.83. B/C ratios increased with higher application rates. With unsubsidized fertilizer the B/C rates at the recommended rates were 1.53 and 1.44, respectively. However, production costs prepared by UCCAO show the profitability of Arabica coffee to be quite marginal.

Robusta Coffee--Fertilization appears less profitable than with Arabica coffee. B/C ratios with the subsidy at the recommended rate were 2.85, 2.54, and 2.06. None of the trials showed the use of unsubsidized fertilizer to be profitable. However, total production costs prepared by UCCAO indicate that the profitability of producing Robusta coffee is more favorable than that of producing Arabica coffee at the average yields and prices indicated by the 1984 Census of Agriculture.

Cocoa--Fertilization is apparently not favorable although the Census indicates that 13,400 farmers fertilized cocoa in 1984.

Producer prices for Arabica coffee, Robusta coffee, and cocoa are all well below the world market price, and increasing the percentage given the farmer would make fertilization of all three crops much more profitable.

Maize--Fertilization appears very profitable. In the northern provinces with the SODECOTON price of FCFA 120,000/mt, B/C ratios were 3.50 or greater for five fertilizers analyzed over four locations. In the southern

provinces, ratios with subsidized fertilizer (FCFA 40,000/mt) were also quite high. Use of completely unsubsidized fertilizer was also profitable, particularly in the North. However, ratios for compound grades now sold in the West were consistently lower. Use of AS, the major fertilizer sold, was unprofitable in one of the trials even when subsidized. This points out the need for improved fertilizer recommendations for maize in the West and North West Provinces. Fertilizers with high phosphate contents were generally the most effective in all trials in both the northern and southern provinces.

Rice--Fertilization with subsidized urea at the recommended rate showed B/C ratios of 5.17 or higher in the five trials. Rice fertilization would also be very profitable even if unsubsidized.

Sorghum--Fertilization with urea at low application rates generally had B/C rates exceeding 1.0. Very little sorghum is currently fertilized. However, because of the large area grown and the government's desire to increase food grain production, sorghum could offer a large market potential.

Cotton--Data to develop response curves for cotton were not available. However, because of the high price received for cotton and the technical assistance provided by SODECOTON, it is believed that fertilization of cotton must show very favorable B/C ratios.

Past research has been carried out generally with monocropping, with improved varieties, and at yield levels higher than those achieved by most farmers. More research is badly needed under farmers' field conditions and with both local and improved varieties to further validate such an analysis as that just given. Yields and prices of crops can vary greatly from one region to another and from year to year, and this can greatly affect the benefits farmers obtain from fertilizer use.

Research as Related to Increased Fertilizer Use Efficiency

The World Bank (1984) in the publication "Toward Sustained Development in Sub-Saharan Africa" states that agricultural research is failing to "provide adequate support for producers of both food and export crops."

The crops that have been studied in detail over the years in Cameroon are the industrial and export crops--namely, oil palm, rubber, banana, pineapple, tea, tobacco, and sugarcane, all of which are grown under plantation conditions--and coffee, cocoa, and cotton, which are grown by the small farmer. However, all of these crops are grown in pure stands for research purposes.

In Cameroon, USAID has paid particular attention to food crops supporting cereal research as well as research on soybean through INTSOY, research on the whole range of semiarid crops through SAFGRAD, and finally, through its support of IRA cropping systems research, covering the major crops and farming systems of Cameroon. By its support of the University of Dschang, USAID is assisting in the development of a strong national agricultural expertise.

The poor fertility levels of Cameroon soils mean that the goal of increasing crop yields can only be achieved by the rational use of fertilizers and complementary mineral treatments with limestone and dolomite to correct the adverse effects of soil acidity and aluminum toxicity. Applied soil fertility research, therefore, must be a priority.

The wide range of agroenvironmental conditions in Cameroon and of soil-related land qualities leads to a particularly complex situation when attempts are made to relate these to the multitude of local cropping systems and to interpret the data in terms of the growth and productivity of crops. At the very best, only locale-specific studies linking soil and climatic variables with the productivity of specific food crops have been made.

The scientific basis of moving soil fertility research work into the field without endless local repitition of work needs to be strengthened. The danger also exists that the research workers will become locked into studying systems that could be swept aside by the advent of one high-yielding variety of a cash crop.

Work on fertilizer response in mixed cropping (traditional) systems has only just begun, and at this stage it seems to be beyond the capabilities of the scientists to achieve any major worthwhile breakthroughs despite the optimism.

Mixed stands of maize and groundnuts, for example, are known to give greater output per unit area than pure stands, i.e., technically, the land equivalent ratio is greater than one. But this is only when maize and groundnuts are grown in lines, giving what in effect is a significant area of two intercropped monocrops. IITA with its development of alley cropping has in effect also pointed itself in the direction of relatively significant areas of sole crops.

This alley cropping approach could have a major implication for the Arabica coffee growers. Early recommendations for the spacing of Arabica were 2 x 2 m. This spacing, given the use of the recommended cultural practices, produced maximum returns per hectare. Intercropping the coffee with traditional crops remained the practice of those small farmers who adopted coffee, but there was no doubt that coffee was the cash crop and came first. As prices of food

crops (particularly maize) have risen, coffee has become a secondary consideration to many growers, and now many Arabica plantations look more like maize and vegetable plantations with severely pruned Arabica intercropped. For this reason, alley cropping of maize and vegetables within rows of more closely spaced Arabica could be attractive.

The alternative will surely be that, as higher yielding maize varieties are bred, in some areas sole maize cropping within a rotation of maize-leguminous crop (such as groundnut) and/or vegetables will develop and coffee production will be abandoned.

There are many areas of the world where farmers have moved faster than the research and extension staff, and where they have not, the reason is more often socioeconomic than technical.

Research Priorities for Cameroon

General Research Issues on Policy Options--Issues and policy options for the whole range of major factors impacting soil fertility research were developed at the IFDC/IRA workshop in Douala in January 1985, and the most pertinent of these are presented below.

1. Issue--National research and extension organizations are either not involved in developing or are not fully informed of national policy decisions affecting crop and input procurement and marketing strategies.
   Policy Option--Information on government plans to produce or procure and market food and fertilizer products should be directed to research and extension organizations so that research and farmer assistance activities and farmer recommendations can be tailored to the changing situation. Particularly, changes in fertilizer products to be imported or produced nationally should be fully discussed, and needed programs of research and farmer education on the use of the new products should be given priority. Crop and input price changes must be made well ahead of the start of the crop season because they may well affect fertilizer recommendations and farmer plans.
2. Issue--Fertilizers are a key item in plans for self-sufficiency in food crops, but their use must be economic. Crop price changes have a greater effect on fertilizer use than do fertilizer price changes. Research must monitor in detail farm-level costs of production and farm budget changes.
3. Issue--Farmers exploit the land and the natural fertility of the soil for gain (food or profit). Long-term adverse effects of agricultural exploitation on soil productivity are of major concern.

Policy Option--Farm ownership patterns and the returns from farming should be such as to encourage good farming practices. Sound soil and water management practices, including drainage and erosion control measures, must be developed and applied as nationally supported programs. Strong research and extension programs are also needed to ensure increasingly better crop yields based on improved soil fertility. Fertilizer efficiency research in terms of improved products and application practices--form, rate, timing, and placement--is needed and must be integrated with good soil fertility management practices.

4. Issue--The soils of Cameroon are, in general, low in fertility. Increased crop production is possible by increasing crop areas and yield per unit area. In either case, it is essential to maintain and, if possible, increase soil productivity.

   Policy Option--Effective use of organic materials, biologically fixed nitrogen, and fertilizers is needed to achieve these two objectives. Only sound government agricultural policies will encourage the farmer to maintain or increase the fertility of his fields.

5. Issue--Adverse soil conditions due to soil acidity and low base status are endemic in Cameroon. These adverse conditions can reduce the efficiency of applied fertilizers, while fertilizers themselves may aggravate the acidity problem.

   Policy Option--National programs are needed to ensure that the adverse effects of soil acidity and base depletion associated with fertilizer use do not reduce crop yields or decrease soil productivity. These programs must be based on research aimed at the economic use of basic materials. Potential use of national limestone resources for converting agricultural lime products should be evaluated and exploited where feasible.

6. Issue--The desired level of integration of research, extension, and farmer knowledge is rarely achieved.

   Policy Option--Institutional structures and linkages and individual attitudes must be changed so that farm-level development is clearly seen as the ultimate objective of both research and extension organizations.

7. Issue--Farmer education is a monopoly of various agencies.

   Policy Option--The commercial sector is capable of supporting, in a complementary way, extension activities aimed at the dissemination of product knowledge, e.g., the types, rates, and methods of application for efficient

fertilizer use when used as a component of a crop production package. Demonstrations, mini-kit schemes, and publicity campaigns run by the commercial sector can strengthen the impact of the government extension service.

8. Issue--Organic matter recycling and the use of organic manures, although proven to be desirable in maintaining and improving soil fertility, are not farming techniques achievable by sedentary farmers, particularly in the drier areas. Organic materials either do not exist in the required quantities or their transfer to the field is too labor intensive, unless associated with livestock movement.

   Policy Option--In problem areas biomass production must be increased over the short term. Research should be directed toward shifting the dynamics of soil organic matter and plant nutrients in farmers' fields in a positive direction and in a way that is economic and practicable.

9. Issue--Farming systems and cropping systems research is complex and long term. Short-term increases in farm-level productivity are needed.

   Policy Option--If low levels of soil fertility are holding down productivity, then research must identify or develop a point in the system where the introduction of fertilizer treatments can be seen by the farmer to be of value.

10. Issue--Fertilizer use recommendations must become more site- and situation-specific in order to be cost effective.

    Policy Option--On-farm research is still generally the monopoly of the cropping systems research teams. More awareness of farm-level fertility problems and the role of fertilizers in correcting these problems can be achieved by actively involving soil fertility researchers with the cropping systems research fieldwork. Land capability maps, field experimentation, and supporting analytical services are needed to refine fertilizer recommendations. In the development of such recommendations, economic and sociological factors must be taken into account, particularly in terms of investment risk and land ownership patterns.

11. Issue--Fertilizer research is generally aimed at increasing the yield of only a portion of the total crop; this is particularly true in the case of grain crops although farmers also value the leaves and stalks.

    Policy Option--The effect of fertilizers on the components of yield and the vegetative composition of the crop must be more fully understood. Fertilizer

response work must integrate both the crop physiology and soil fertility aspects of crop yields.

Fertilizer-Specific Research Needs

In addition to ongoing research in the area of soil fertility, specific items needing urgent attention will be identified from time to time. Those that need immediate attention at this stage are described below.

1. a. Urea will increasingly replace ammonium sulfate, which will be used only where sulfur is known to be deficient and then primarily with the objective of meeting sulfur needs.

   Urea may lose a considerable portion of its nitrogen when it is applied to the soil surface (or in the case of irrigated rice dissolved in the floodwater). Under the rainy conditions of the east, south, and west, application just before rain is expected will probably be adequate to eliminate or reduce ammonia volatilization losses. During dry periods, however, unless the urea is thoroughly mixed with the soil, losses could be high. Studies should be made of the degree of loss from surface-applied urea and where risks of loss are high and surface incorporation is not possible, the use of split doses of urea or of urea solutions should be evaluated.

   b. Diammonium phosphate can lose ammonia also when applied on the soil surface. Studies similar to these for urea are needed.

   c. Soil acidity and aluminum toxicity can limit crop yields.

   A combined research/demonstration program using simple kits should be developed to show farmers the losses of fertilizer efficiency occuring when nitrogenous and phosphatic fertilizers are incorrectly used and also the adverse effects of soil acidity and aluminum toxicity. These kits should also demonstrate the danger of seedling toxicity when fertilizers, particularly urea and DAP, are incorrectly placed.

2. Two phosphate products have a role to play in Cameroon agriculture--MAP and DAP. Although very high in phosphate, the two materials are chemically very different. Comparisons of the efficiency of MAP and DAP under a wide range of soil conditions should be made. These should be done first as pot experiments, with field experiments being developed following analysis of the results.

3. Correct fertilizer placement and timing are critical. Research results should evaluate labor costs in relation to correct timing and placement and the resultant benefits in terms of crop yields.
4. Maximum yield data (plant population, date of planting, variety, fertilizer treatment, etc.) should be obtained for the key cash crops. This information should be widely distributed by the extension service as an encouragement to move toward multiple line planting and to stimulate interest in fertilizer use. Farmer competitions for maximum crop production/unit area performance should also be encouraged, and the techniques of the winning farmers should be fully discussed by subject matter specialists on the radio.
5. Mineral nutritional status surveys of the key cash crops should be regularly undertaken; both soil and plant tissue analyses should be used for the information base. These could be done at carefully selected benchmark sites with satellite sampling areas.

   Such work is predicated upon functioning sampling, sample preparations, and analytical and interpretative services using a computerized data base managed by a biometrician trained in modern statistical methodologies as they relate to total cropping systems.
6. The economics of fertilizer use should be continually monitored using actual farm-level data.

SECTION I

CAMEROON AGRICULTURE AND FERTILIZER USE

PART II--HISTORICAL AND FUTURE TRENDS IN FERTILIZER CONSUMPTION

Historical Fertilizer Consumption

There is no one agency in Cameroon that maintains official statistics of fertilizer consumption. Data on subsidizied deliveries (not consumption) for the past 10 years can be obtained from the DIRAGRI in the Ministry of Agriculture. Actual product consumption for 1982/83 and 1983/84 was reported by several of the parastatals to the Ministry of Agriculture, Division of Agricultural Statistics. Data on product imports (some years by agency) can be obtained from private importers. Some import statistics by product are also available from Customs and the National Statistics and Accounting Office but are not complete. Some agencies maintain data on a calendar year, some on a July-June year (government), and some on an October-September year.

Losses of imported fertilizer are high, and out-of-condition products resulting from high rainfall during certain periods make some delivered products unusable. There is a large tonnage of "soupy" unusable products at the FONADER warehouse in Bonaberi that were imported but never delivered. Some agencies such as SODECOTON import fertilizer one year in advance in order to ensure their supplies. Data on stocks by years were very limited at all agencies visited. All of these factors make it difficult to accurately determine historical fertilizer consumption, particularly by product. Most studies in the past, because of these complexities, overestimated current consumption, and as a result projections made from these data were also overestimated. Also, because two distinct fertilizer sectors now exist (subsidized and unsubsidized), some studies have erroneously added the subsidized usage and the agro-industrial usage together. This results in double counting as some agro-industrial parastatals receive subsidized fertilizer. We do not claim that our consumption estimates are free of all the above problems, but we do believe that they are reasonably accurate.

The amount of fertilizer subsidized in Cameroon has increased from 14,807 mt in 1974/75 (1975) to 65,313 mt in 1984/85 (1985) according to Ministry of Agriculture records (Table I-54). This represents an annual growth rate of 16%

Table I-54. Subsidized Fertilizer Deliveries

Year	Grade	mt	Cost/mt (FCFA)	Price/ mt (FCFA)
1974/75	AS	-	66,140	36,000
	NPK	-	83,545	45,000
	Total	14,807		
1975/76	AS	-	66,140	30,000
	NPK	-	83,545	45,000
	Total	18,000		
1976/77	AS	15,458	75,000	30,000
	NPK	13,102	95,500	36,000
	Divers	3,215	-	-
	Total	31,775		
1977/78	AS	22,375	48,000	26,000
	NPK	13,000	65,800	32,000
	Total	35,375		
1978/79	AS	20,680	51,376	26,000
	NPK	18,000	74,108	32,000
	Total	38,680		
1979/80	AS	24,500	57,500	28,000
	NPK	10,000	82,500	32,000
	Total	34,500		
1980/81	AS	30,000	62,375	28,000
	NPK	14,000	89,495	32,000
	Total	44,000		
1981/82	AS	20,000	57,700	35,000
	NPK	22,000	77,500	35,000
	Total	42,000		
1982/83	AS	38,000	53,850	40,000
	NPK	40,000	79,730	40,000
	Total	78,000		
1983/84	AS	35,000	55,250	40,000
	NPK	45,000	89,000	40,000
	Urea	2,826	-	40,000
	Total	82,826		
1984/85	AS	18,000	70,000	40,000
	NPK	32,313	114,000	40,000
	Urea	15,000	-	40,000
	Total	65,313		

Souce: Ministry of Agriculture.

during this period. However, part of this growth represents agencies such as SEMRY and SODEBLE that received unsubsidized fertilizer in the past but are now receiving subsidized fertilizer. Similar figures for the unsubsidized sector for the past 10 years are not available, but this unsubsidized use has been more constant because the growth in use by the export crop parastatals such as SODECOTON, CDC, etc., has been offset by other agencies that now obtain subsidized instead of unsubsidized fertilizer. We would estimate that nonsubsidized use has ranged from 35,000 to 45,000 product mt in recent years.

Total fertilizer consumption in the past 5 years has increased from almost 85,692 mt in 1980/81 (1981) to 105,056 mt in 1984/85 (1985) according to consumption figures that IFDC has compiled by agency (Table I-55). This represents an annual growth rate of 5.2% during this period. However, most of this growth occurred in the subsidized sector between 1981/82 and 1982/83 when subsidized sales increased sharply (78,439 mt versus 58,569 mt) despite a 14% increase in the subsidized price. Product growth since 1982/83 has stagnated. Because of a lack of adequate funding for subsidized fertilizer in 1984/85, total consumption of all fertilizer products in Cameroon declined from 124,066 mt the previous year to 105,056 mt, a decline of 15% even though subsidized prices remained unchanged.

Fertilizer Product and Nutrient Use

Fertilizer consumption by product is shown in Table I-56. In 1980/81 ammonium sulfate was the leading fertilizer consumed in Cameroon and represented almost 40% of total consumption. Consumption of ammonium sulfate in 1984/85 was half that of 1980/81 and now represents only 16% of the total consumption. Consumption of urea has grown significantly during this period, particularly in 1984/85. Another fertilizer with a rapid growth in use has been 20-10-10 although its use declined significantly in 1984/85 because of funding problems in the subsidized sector. However, last year (1983/84) it represented 38% of total product consumption.

Total nutrient consumption since 1980/81 has increased from 31,803 mt to 42,890 mt in 1984/85 for a growth rate of 7.8% annually (Table I-57). As with products, nutrient growth has stagnated since 1982/83. However, in 1984/85 product growth dropped 15% while nutrient growth declined less than 6% as farmers used higher analysis products. In 1980/81 the average product contained 37% nutrients, and in 1984/85 the average nutrient content was 41%. This trend to higher analysis fertilizers is expected to continue.

Table I-55. Historical Fertilizer Consumption by Agency and Province

	1981	1982	1983	1984	1985
	(mt of product)				
Center and South Provinces					
DIRAGRI (SOA)	0	0	25	0	0
DPA (C&S)	0	0	0	637	617
DPACS	0	0	145	0	0
ELITES	0	0	0	66	0
MIDEVIV	337	301	415	422	287
MIDO	0	0	190	250	38
CENEEMA	0	0	0	225	0
MISSION CATHOLIC	0	0	30	30	0
OMBESSA	0	0	190	47	0
UNSPECIFIED	374	290	0	0	0
DPA SOUTH	0	0	0	0	52
Subtotal	711	591	995	1,677	994
West Province					
UNSPECIFIED-W	2,800	0	0	0	0
COOPAGRO	0	0	0	2,000	0
DPA-WEST	0	0	0	2,605	0
SODERIM	0	0	87	719	600
UCCAO	20,516	30,276	27,000	30,000	20,296
Subtotal	23,316	30,276	27,087	35,325	20,896
East Province					
CFSO	860	825	950	940	900
DPAE-EAST	0	0	370	370	320
FOPAYONO	0	0	50	0	0
S.A. KADEY	0	0	20	0	0
UNSPECIFIED	1,273	1,620	0	0	0
ZAPI-EST	1,178	0	815	1,294	205
CAMSUCO	2,897	2,897	3,679	4,160	3,160
SOSUCAM	2,239	2,239	2,239	1,999	1,840
SCT	55	55	55	55	55
Subtotal	8,502	7,636	8,178	8,818	6,480
Northern Provinces					
DPA ADAMOU	0	0	0	0	150
DPAN	0	0	0	400	0
MISSION BENOUE	0	0	0	900	50
PROJECT KENAF	0	0	70	100	50
SEMRY	2,140	2,950	3,682	4,139	4,504
SODEBLE	291	2,027	2,214	1,729	350
UNSPECIFIED-NORTH	685	40	0	15	0
SODECOTON	14,623	12,304	16,782	17,501	22,020
WEKWA (CENTRE)	0	0	0	0	60
Subtotal	17,739	17,321	22,748	24,784	27,184

(Continued)

Table I-55. Historical Fertilizer Consumption by Agency and Province (Continued)

	1981	1982	1983	1984	1985
	(mt of product)				
Littoral Province					
ANACAM	200	200	200	200	200
LITTORAL COOPS	0	0	27,210	4,950	16,668
PLANTERS (DPAL)	0	0	0	19,935	0
SODENKAM	1,400	1,400	1,400	1,400	1,024
STOCKS	0	0	0	0	3,623
UNSPECIFIED-L	12,081	11,600	0	0	0
BONABERI SALES	0	0	0	0	5,742
SOCAPALM	3,615	2,500	3,720	2,039	4,060
HEVECAM	1,750	2,010	2,690	2,600	2,510
OCB	2,800	2,800	2,800	1,780	1,780
SAFACAM	655	655	469	655	655
SPFS	190	190	190	240	240
FONADER CLIENTS	502	600	0	0	0
Subtotal	23,193	21,955	38,679	33,799	36,502
South West Province					
SW COOP	600	1,750	3,000	2,510	2,918
DPASO	0	0	0	950	950
CDC	4,063	3,963	3,863	3,067	2,708
PAMOL	2,004	2,394	1,497	2,198	1,696
Subtotal	6,667	8,107	8,360	8,725	8,272
North West Province					
DPANO	0	0	0	5,800	0
NWCA	0	0	9,500	3,823	4,514
UNSPECIFIED	5,400	4,100	0	0	0
UNVDA	125	525	635	716	195
WADA-WUM	39	65	241	600	19
Subtotal	5,564	4,690	10,376	10,939	4,728
TOTAL	85,692	90,576	116,423	124,066	105,056

Note: Some agencies shown as not consuming subsidized fertilizer in some years may have gotten supplies from another agency rather than directly from the Ministry of Agriculture.

Source: IFDC Survey, November 1985.

Table I-56. Cameroon: Total Fertilizer Consumption by Product, 1980/81-1984/85

	1980/81	1981/82	1982/83	1983/84	1984/85
			(mt)		
21-0-0 (AS)	32,569	27,616	42,062	38,677	16,368
20-10-10	14,403	31,930	36,540	47,042	27,439
12-6-20	0	0	30	50	11,812
Urea	6,752	4,323	6,868	9,400	16,704
Phosphate rock	2,036	2,794	3,311	2,775	2,899
DAP	1,857	2,346	1,864	2,073	1,506
TSP	38	114	232	322	364
KCl	10,258	9,182	9,162	8,493	8,653
10-10-20	550	400	790	300	940
SSP	36	36	36	36	10
K_2SO_4	10	10	10	10	10
18-9-9	5,000	0	0	0	0
15-15-15-6S-1B	0	0	13,794	12,924	4,354
15-20-15-6S-1B	12,183	10,151	0	0	6,354
22-10-15-6S-1B	0	0	0	758	7,643
6-20-20	0	1,374	1,724	1,206	0
10-30-10	0	300	0	0	0
TOTAL	85,692	90,576	116,423	124,066	105,056

Note: Statistics include only products containing N, P, or K. Micronutrients and other fertilizer products such as kieserite and dolomite are not included.

Source: IFDC Survey, November 1985.

Table I-57. Fertilizer Nutrient Consumption, 1980/81-1984/85

Nutrient	1980/81	1981/82	1982/83	1983/84	1984/85
	(mt)				
N	15,943	16,271	21,891	24,441	21,679
P_2O_5	5,872	7,605	8,113	8,934	7,967
K_2O	9,988	10,615	11,734	12,168	13,243
Total	31,803	34,491	41,738	45,543	42,890
Product tons	85,692	90,576	116,423	124,066	105,056
% nutrients	37	38	36	37	41

Source: IFDC Survey, November 1985.

Table I-58. Cameroon Fertilizer Nutrient Consumption

Year	N	P_2O_5	K_2O	Total
	(mt)			
1973/74	9,326	2,304	4,550	16,180
1974/75	9,763	2,128	4,763	16,654
1975/76	6,100	3,000	3,100	12,200
1976/77	4,000	2,171	6,878	13,049
1977/78	14,600	7,000	12,400	34,000
1978/79	15,400	6,900	13,300	35,600
1979/80	14,200	5,508	12,900	32,608
1980/81	18,100	7,312	10,270	35,682
1981/82	22,700	7,300	10,200	40,200
1982/83	24,200	5,200	10,500	39,900
1983/84	12,800	4,500	16,000	38,300

Note: Phosphate statistics do not include rock phosphate. This would have added about 900 mt of P_2O_5 in 1983/84.

Source: FAO fertilizer tape as compiled by TVA.

Fertilizer nutrient consumption as reported by FAO for Cameroon during the past 10 years is shown in Table I-58. These data indicate that for the past 10 years nutrient consumption has increased by an average of 9.0%/year. Agency product data shown in Table I-58 indicate that N consumption is higher than that reported by FAO. Total nutrient consumption is considerably below the levels indicated by the IFDC survey which is shown in Table I-57.

In Table I-55 consumption of fertilizer was shown by the agency from which it was purchased. These same data are summarized by Province in Table I-59. Most of these agencies such as the co-ops, DPA's, etc., obviously do not consume fertilizer (some such as CDC, etc., do) but instead resell the fertilizer to farmers. A comparison of the fertilizer consumption data based on direct movements from Bonaberi with those data obtained by field survey during the 1984 Agricultural Census indicates that a substantial secondary movement of fertilizers (6,000-12,000 mt) must occur from the Littoral to the West Province. Thus a substantial quantity of the sales from Bonaberi and other places in the Littoral Province may be sold for use in other Provinces.

The Provincial Delegate of Agriculture in January 1986 confirmed the figures shown in Table I-55. The 1984 Census data, which are based on where the fertilizer is used, indicate that the consumption in the Littoral Province was lower than indicated by the IFDC survey (which is based on where purchased) and that consumption in the West was higher. We suspect that 6,000-12,000 mt of fertilizer is purchased in the Littoral Province and used in the West each year, but we are unable to confirm this.

In 1984/85, approximately 64,332 product mt of subsidized fertilizer and 40,724 mt of unsubsidized fertilizer were consumed in Cameroon (Table I-60). Subsidized fertilizer use was down sharply from 87,772 mt the previous year.

The 1984 Census of Agriculture indicated that 375,600 farmers in Cameroon used 140,240 product mt of chemical fertilizer in 1984 (Table I-61). With a total of 1.15 million farms, this means that fewer than one-third of the farmers use fertilizer. Although the Census total is more than was imported, the figures give some additional insight on use by Province and use per farm.

Totals from the 1984 Census of Agriculture on fertilizer use and from the IFDC 1985 survey of consumption by Province, based on point of purchase, can be compared (Table I-62). The major differences are in the West Province where UCCAO is the principal supplier. Figures provided by UCCAO to IFDC in November 1985 indicate that 20,300 mt was used by their customers in 1985. However, in Table I-62 consumption based on point of purchase in the Littoral Province was 33,799 mt versus census figures based on point of use of 21,050 mt. This means

Table I-59. Historical Fertilizer Consumption by Province Based on Where Purchased

Province	1980/81	1981/82	1982/83	1983/84	1984/85
	(mt)				
Center and South	711	591	995	1,677	994
West	23,316	30,276	27,087	35,324	20,896
East	8,502	7,636	8,178	8,818	6,480
Northern	17,739	17,321	22,748	24,784	27,184
Littoral	23,193	21,955	38,679	33,799	36,502
South West	6,667	8,107	8,360	8,725	8,272
North West	5,564	4,690	10,376	10,939	4,728
Cameroon	85,692	90,576	116,423	124,066	105,056

Note: Fertilizer may be purchased from an agency in one province and used in another. Consumption in the West Province may be understated 6,000-12,000 mt and overstated in the Littoral Province by the same amount because of this.

Source: IFDC survey, November 1985.

Table I-60. Subsidized and Unsubsidized Fertilizer Usage by Province, 1984/85

Province	Subsidized	Unsubsidized	Total
	(mt)		
Center and South	994	0	994
West	20,896	0	20,896
East	1,425	5,055	6,480
Northern Provinces	5,164	22,020	27,184
Littoral	27,257	9,245	36,502
South West	3,868	4,404	8,272
North West	4,728	0	4,728
Cameroon Total	64,332	40,724	105,056

Source: IFDC survey, November 1985.

Table I-61. Census Estimates of Chemical Fertilizer Use, 1984

Province	Farm Using	AS/Urea	Compound	Other	Total	kg/Farm
	(mt)					
Extreme North	97,100	4,920	7,940	80	12,940	133
North	57,200	3,220	9,850	a	13,070	228
Adamaoua	8,700	360	1,090	a	1,450	167
East	8,200	460	1,790	a	2,250	274
Central	3,200	290	370	a	660	206
South	100	a	a	a	a	-
Littoral	26,600	8,980	11,850	220	21,050	791
South West	7,600	2,370	1,280	50	3,700	487
North West	48,900	7,640	5,710	a	13,350	273
West	119,000	32,550	39,220	a	71,770	603
Cameroon Total	375,600[b]	60,790	79,100	350	140,240	373

a. Less than 10 mt.
b. Parts may not sum to totals due to multiple counts.

Source: 1984 Agricultural Census.

Table I-62. Comparison of IFDC Survey Data and Census Data for 1984 Consumption

Region	Ag Census	IFDC	Ag Census	IFDC
	(mt)		(% of Cameroon)	
Center and South	660	1,677	.6	1.4
West	41,090	35,324	37.4	28.5
East	2,250	8,818	2.1	7.1
Northern Provinces	27,460	24,784	25.1	20.0
Littoral	21,050	33,799	19.2	27.2
South West	3,700	8,725	3.4	7.0
North West	13,350	10,939	12.2	8.8
Cameroon Total	109,560	124,066	100.0	100.0

Source: 1984 Agricultural Census and IFDC Survey, November 1985.

as much as 12,000 mt may be being bought in the Littoral Province and used in the West Province. We do not feel that any significant quantity was imported from Nigeria which could account for the difference.

Fertilizer Use by Crop

Statistics are not published on fertilizer use by crop. However, rough estimates of this can be made on the basis of the agency to which it is shipped, particularly for the plantation crops.

The major problem is that coffee is intercropped with maize and other crops. Fertilizer is often applied to both, and it is difficult to distinguish whether the fertilizer is being applied to the maize or to the coffee. Obviously, the maize that is intercropped in the coffee benefits from any fertilizer applied to the coffee. In the northern provinces, monocropping of maize is a standard practice.

A survey of 480 farmers in the North West Province in 1983 indicated that 95% of the farmers grew maize in mixed culture (IRA, 1983). However, less than 7% of the maize farmers intercropped coffee with maize. Approximately 71% grew beans, 43% grew cocoyams, 28% grew sweet potatoes, and 21% raised cassava with maize. Thus, something less than 7% of the maize is an intercrop of coffee if the average farm size is relatively the same. The report states, "The use of fertilizer on maize (as opposed to cash crops such as coffee and rice) is not very widespread (23%)."

The 1984 Census of Agriculture provides data on the percentage of the different types of farmers who use fertilizer or manure by crop (50% of the farmers using manure were in the three northern provinces). It groups all food crops together; however, almost all fertilizer used on food crops is used on maize except in the north where the rice is grown. This indicates fertilization for about one-half of the coffee and for 19% and 35% of the maize in the North West and West Provinces, respectively (Table I-63).

Also, the Census provides data on the average size of coffee and maize farms; thus, by multiplying the number of farms of each crop fertilized by the average size we can determine a rough idea of hectarage of each crop that is fertilized. If we then assume that 250 kg of 20-10-10 is recommended for maize and 400 kg of 20-10-10 fertilizer is recommended for coffee and further assume that both groups of farmers use the same percentage of the recommended rate and that the average size of farm that is fertilized is the same as the average farm size not fertilized, we can calculate the percentage for fertilizer used on coffee and maize in provinces where both crops are grown. The results are shown in Table I-64.

Table I-63. Estimates of Maize Farmers and Coffee Farmers Who Use Fertilizer or Manure

Region	Food-Crop Farmers Who Use Fertilizer or Manure	Total Maize Farmers	% Using	Coffee Farmers Who Use Fertilizer or Manure	Total Coffee Farmers	% Using
Extreme North	118,800	47,600	a	-	-	-
North	32,400	40,600	a	-	-	-
Adamaoua	12,000	34,000	a	1,100	3,700	40
East	5,300	55,600	10	12,700	39,500	32
Central	3,100	147,400	2	600	22,400	3
South	200	46,300	0	a	3,300	-
Littoral	5,200	54,000	10	23,700	37,200	64
South West	8,600	52,400	16	7,200	38,200	19
North West	25,100	129,500	19	41,600	116,900	36
West	53,300	154,100	35	114,000	151,000	75
	264,000	761,500	a	200,900	412,200	49

a. Almost all the fertilizer used by food crops is on maize except in the North where fertilizer is used on rice.

Source: 1984 Census of Agriculture.

Table I-64. Percentage of Fertilizer Used on Coffee and Maize by Province Where Both Are Grown

Provinces	Percent Used on Coffee	Percent Used on Maize
East	92	8
Central	68	32
Littoral	98	2
South West	90	10
North West	72	28
West	84	16

Source: Derived using 1984 Census of Agriculture data and procedures and assumptions described above.

In discussing this situation with specialists who have lived in the areas and are familiar with coffee and maize intercropping, it was estimated that, in the North West Province where 7% or less of the maize is grown with coffee, 10% of the fertilizer was used on maize and 90% on coffee. The same specialists estimated that 30% of the maize is grown with coffee in the West Province and that 25%-30% of the fertilizer is used on maize and the remainder on coffee.

Therefore, in order to estimate fertilizer use by crop we have used the assumptions in Table I-65. Coffee is the biggest user of fertilizer in Cameroon, consuming about 47% of the total product tons (Table I-66). Food crops, primarily maize, consume about 15% of the total fertilizer or about 24% of the subsidized fertilizer.

Projected Fertilizer Consumption

There are a number of methods available for making fertilizer projections (Harris, 1985). These include trend extrapolation, leading indicators, agronomic requirements, food requirements, survey method, delphi method, use of experts, percentage growth rates, absolute growth rates, and cause and effect regression. There is no one best method for forecasting. The selection of the method to use involves a number of factors including time and data available, accuracy of data, years of data available, and relevancy of historical conditions. Often more than one method can be used to serve as a check on another method or to set projection ranges.

Projection Methodology

The first step in this study was to develop the most accurate historical data available. The tonnages of subsidized deliveries by agency were obtained from the Ministry of Agriculture. These data were adjusted slightly in cases where deliveries were made in one year but stocks were carried over for use in subsequent years. This information was further supplemented for 1984/85 with 1985 deliveries through October 15, 1985 as reported by the FONADER warehouse at Bonaberi. One difficulty with these data is that an agency may buy fertilizer directly from the Ministry one year, which is recorded on Ministry of Agriculture documents, and the next year may purchase the fertilizer from the DPA or a local co-op and thereby not be shown as consuming fertilizer on the

Table I-65. Assumed Use of Fertilizer by Coffee and Food Crops by Province

Province or Agency	Food Crops	Coffee	Other	Total
	(%)			
Subsidized				
Northern Provinces	100	-	-	100
East	10	90	-	100
Central and South	10	90	-	100
Littoral	10	90	-	100
South West	10	90	-	100
North West	10	90	-	100
West	30	70	-	100
Unsubsidized				
SODECOTON	5	-	95	100
Others	-	-	100	100

Source: IFDC.

Table I-66. Fertilizer Use by Crop, 1985

Crop	Product Metric Tons	Percent of Total
Food crops	16,259	15
Coffee	49,073	47
Oil palm	7,720	7
Cotton	21,020	20
Rubber	2,810	3
Bananas	2,018	2
Tea	1,101	1
Sugar	5,000	5
Tobacco	55	-
TOTAL	105,056	100

Source: IFDC.

Ministry of Agriculture records. Another problem with using Ministry of Agriculture records on subsidized fertilizer is that some agencies that received subsidized fertilizer in 1985 used unsubsidized fertilizer in earlier years. Data on imports of unsubsidized fertilizer were obtained from various Ministry of Agriculture offices including the Direction of Agriculture and Division of Statistics and from private importers in Douala. Again import data were not complete, and more fertilizer may be imported than is used that year. Agencies handling subsidized fertilizer also imported larger quantities in one year when funding for subsidies was available and then imported smaller quantities when financing for fertilizer purchases declined.

The team visited almost every agency, co-op, DPA, etc., selling 100 mt or more of product to verify or supplement the shipment information and data obtained from other sources. An attempt was made to obtain data on actual sales by year as this may differ from shipment data if stocks are carried over from one year to the next. Sales or consumption information was generally available for the past 2-3 years at many agencies and for 5 years at some of the parastatals. Data on stocks were not usually available; therefore, in cases where deliveries appeared to be for more than one year's use, estimates were made on how much of the delivered fertilizer was consumed each year. However, most agencies report that the amount of stocks carried over does not change greatly from one year to the next although there were exceptions to this. Furthermore it is sometimes very difficult to obtain, even locally, accurate historical figures on sales or consumption because stock records and sales data are frequently nonexistent. Even amounts reported by parastatals often differed from amounts they had reported earlier to various Ministry of Agriculture agencies or that had been obtained in previous studies.

After the historical product consumption was determined, the next step was to convert this tonnage into historical nutrient tonnage (N, P_2O_5, and K_2O). Agency data were then aggregated into geographical regions which consisted of one to three Provinces based on Ministry of Agriculture data groupings.

Development of Scenarios

In order to make future fertilizer consumption projections, four scenarios were developed. The basic assumptions and methodology used are discussed as follows.

Scenario I--Present Marketing System With Current Fertilizer/Crop Price Ratios--Scenario I assumes that the existing procedures used to import,

subsidize, distribute, and sell fertilizers used in 1985 would continue through 1995 and that the three major products subsidized in the past (urea, AS, and 20-10-10) would continue to be the major products used in the subsidized sector. In 1985, 12-6-20 was used, but purchases were made mainly because 20-10-10 was not available in sufficient quantities. It was assumed that the unsubsidized parastatals would continue to import products of their choice as they do now. Problems with late delivery and lack of availability of desired products in the subsidized sector were assumed to continue. It was also assumed that some funding problems for providing subsidized fertilizer would continue as they have in the past, and it was recognized that it might be difficult to continue the subsidy past 1990 as oil revenues decline and increasing fertilizer prices and fertilizer volumes significantly increase the cost of the fertilizer subsidy. However, in this scenario it was assumed that fertilizer/crop price ratios would not change significantly in the future. If fertilizer prices moved higher, it was assumed that crop prices would increase to maintain current price ratios.

Projections were made separately for all agencies subsidized in 1985 and for the nonsubsidized organizations, which primarily produce export crops. Because 1985 consumption in the subsidized sector was limited by funding constraints, a "1985 base year" was developed as the starting point for the forecasts for the subsidized sector. This was the average consumption for the last 3 years. This procedure was used because some agencies may have carried over stocks and reduced apparent consumption in the following year. Thus, it was felt that a 3-year average gave a better indication of what "true" consumption each year actually is. In most cases the 3-year average was higher than the actual (apparent) 1985 consumption.

It is impossible to develop accurate trends by agency or province in the subsidized sector because of limited historical data and the way purchases are made and because limited funding for subsidized purchases has affected the amount of fertilizer available; therefore, projections were made first at the national level. Growth rates were used rather than trend extrapolation because of the effect that limited funding has had in some years. The projected growth rates used were based on past growth rates, discussions with agencies, and the team's experience with other developing countries. Projections were first made on a nutrient basis, and these forecasts were then converted to product metric tons. This was done because the average nutrient content of the fertilizers used is increasing, as is the case when urea (46% N) is substituted for AS (21% N). In developing product projections it was assumed that only three grades--AS, urea, and 20-10-10--would be used after 1987. The first step was to project the

declining AS consumption. Then the 6% projected growth in phosphate was met by the 20-10-10 consumption. The remaining nitrogen required to meet the 6% growth rate determined the amount of urea needed.

Projections by geographic area in the subsidized sector were made by calculating the 3-year average percentage of each product consumed and assuming that this "share" of each product would continue in the future. Arguments could be made for increasing the "shares" in the major food crop areas. However, the government is committed to increasing use in all areas. Also it is not clear how "shares" in the major food-crop provinces could be increased substantially because they are already large.

Projections were made by crops by estimating the current percentage of use by each crop in each province. This share of use for each crop in each province was then projected. It should be pointed out that little information on use by crop is available and that estimates are largely based on the judgment of knowledgeable specialists.

Consumption projections for the nonsubsidized export crop sector were made differently. Fertilizer use in these organizations is based on recommendations of commercial agronomists. Use, although steadily increasing, does not fluctuate significantly from year to year in terms of either products or nutrients. Most agencies indicated they expected a small annual growth in product use over the next 5 years. The actual rates used in projections varied by agency and were based on discussions with their personnel and historical rates of change in use. Projections for most agencies were about 5%. However, the rate ranged from no growth in use on sugar to as high as 20%/year growth in use on food crops by SODECOTON. The rate selected for each crop produced by each agency was used throughout the projection period and applied to actual product use in 1985.

Projections of product use were then reviewed by the IFDC team visiting each agency or parastatal, and adjustments were made as judged appropriate. Projections were further reviewed with other specialists in the Ministry and elsewhere who are familiar with the agricultural region or organizations in the region.

Scenario II--Recommended Marketing System With Current Fertilizer/Crop Price Relationships--The second scenario developed is called the "recommended" scenario. This assumes that the recommended marketing system described in Section II will be in place by 1987 and fully operational in 1988. Projections for the "recommended" scenario assume the following:

1. The recommended fertilizer will be available to all farmers in Cameroon in adequate quantities when needed.

2. Fertilizer subsidies will be removed gradually and completely phased out by 1990.
3. Coffee producers will receive a higher percentage of world market prices as the cost of subsidizing fertilizer is eliminated. It should be pointed out, however, that FONADER indicated that most of the subsidy has been paid in recent years from appropriated funds generated from oil revenues.
4. Food grain prices will be strengthened as the government continues to encourage increased production. Money from appropriated sources and perhaps oil revenues will be used to adequately finance an organization such as a cereals authority that can ensure adequate markets for cereals in rural areas through such actions as guaranteeing minimum cereal prices, establishing procedures for co-ops and parastatals to purchase cereals from farmers, and establishing storage programs.
5. Fertilizer prices will increase as the fertilizer subsidy is removed, but current fertilizer/crop price ratios will not change significantly.
6. Adequate farm credit will be available.
7. A substantial fertilizer promotion effort will be made. Marketing and extension personnel will substantially improve farmers' knowledge of fertilizers.
8. The recommended system will primarily affect only the consumption in the subsidized sector. Although it may provide fertilizer to the unsubsidized sector, it will not substantially alter the consumption because this is presently based on the recommendation of commercial agronomists.

Projection methodology with the recommended marketing system was similar to that used for the current system except that different growth rates were used. One of the main features of the recommended marketing system as described in the agronomic section will be to promote use of high-phosphate fertilizers as well as to market all fertilizers more effectively and efficiently. The high-phosphate fertilizer to be sold with the new marketing system is 10-30-10. This will be used mainly for food crops in combination with urea and will stabilize 20-10-10 use at or near current levels.

It was assumed that the new marketing system would not alter consumption until 1988 although the recommended system will sell 6,000 mt in 1987. This was assumed to be tonnage that would have been sold anyway. Projections were first made on a nutrient basis and then converted to product metric tons. It was assumed, on the basis of the proposed marketing plan, that nitrogen use could be increased 10%/year and phosphate use could be increased 17%/year. It was assumed

that AS would be phased out in exactly the same way as it would be with the current marketing system.

The tonnage of 10-30-10 to be sold was projected first. This would be 4,000 mt in 1988 and reach 40,000 mt by 1995. The remaining phosphate requirement would be met with 20-10-10. Projecting the amount of urea needed to meet the nitrogen requirement after projections of the other three products were made was the fourth step. Potash was treated as the residual supplied by 20-10-10 and 10-30-10.

Scenario III--Present Marketing System With High Fertilizer/Crop Price Ratios--This scenario was made using exactly the same assumptions as in Scenario I (Present Marketing System With Current Fertilizer/Crop Price Ratios) except that it was assumed that the price ratios would not be nearly as favorable. It was assumed that the fertilizer subsidy would gradually be removed by 1991 and that crop prices would increase but at a much slower rate.

Data on how responsive fertilizer consumption is to fertilizer price changes were not available. Often changes in consumption have been in response to availability or nonavailability rather than price. Even in years where fertilizer prices were not changed, consumption has changed significantly. Because reliable data on stocks are not available, even consumption estimates are relatively crude. Data on crop prices except for coffee vary considerably from month to month and by geographical area. Thus, sufficient reliable data were not available on which to estimate demand elasticities. The effect on consumption was based on the following assumptions.

1. Consumption in the estate sector would not be changed because these organizations are now buying unsubsidized fertilizer. SODECOTON does discount some of the price of fertilizer (farmers pay FCFA 120,000/mt versus FCFA 160,000/mt that the fertilizer costs SODECOTON), but basically this subsidy is eventually reflected in the cotton price received by the small farmer. However, a lower growth rate was used in the North than in Scenario I for food-crop use that was not subsidized in 1985. In Scenario I this sector where use is currently small was assumed to increase 20%/year. The benefit/cost ratios of food crops in the North are very high even with unsubsidized fertilizer. Thus, this growth rate was reduced only slightly to 15%.
2. The food crops in the sector that was subsidized in 1985 and that showed relatively high benefit/cost ratios would achieve 50% of the growth they would have achieved with current price ratios.

3. Coffee where benefit/cost ratios are not as favorable would achieve only 20% of the growth they would have achieved with the present fertilizer/crop price ratios.

Scenario IV--Recommended Marketing System With High Fertilizer/Crop Price Ratios--This scenario was developed with exactly the same assumptions as Scenario II (Recommended Marketing System With Current Fertilizer/Crop Price Relationships) except that it was assumed that the price ratios would not be nearly as favorable. It was assumed that the fertilizer subsidy would be gradually removed by 1991 and that crop prices would increase but at a much slower rate.

Again, price elasticities were not available, and the effect on consumption was estimated on the basis of the following assumptions.

1. The recommended system could overcome much of the negative effect of higher prices.
2. Growth in the 1985 unsubsidized food-crop sector would be 15%/year compared with 20% used in Scenario II. Growth for other estate crops that are currently unsubsidized would not be affected. SODECOTON does subsidize some of the price of fertilizer (farmers pay FCFA 120,000/mt for fertilizer costing SODECOTON FCFA 160,000/mt), but basically the subsidy is eventually reflected in the cotton price received by the small farmer.
3. Food crops that were subsidized in 1985 and where benefit/cost ratios are already high would achieve 75% of the growth they would have achieved with current price ratios.
4. Coffee, with benefit/cost ratios that are not as favorable, would achieve only 65% of the growth they would have achieved with current price relationships.

Fertilizer Consumption Projections

Fertilizer consumption levels are related directly to the efficiency of the fertilizer marketing system and to the fertilizer/crop price ratios. Thus, projections were made with four Scenarios. Scenarios I and II are the present and recommended marketing system with current fertilizer/crop price ratios, and Scenarios III and IV are the present and recommended marketing systems with high fertilizer/crop price ratios. Details concerning the methodology used are presented in the Projection Methodology Section. Detailed projections by product, by nutrient, by province or provincial grouping, and by crop are shown in Appendixes A-O.

Scenario I--Projections With Present Marketing System and Current Fertilizer/Crop Price Ratios--As described in the methodology section, projections with the present marketing system with current fertilizer/crop price ratios for the sector that was subsidized in 1985 were made first by projecting the nutrient tonnage (Table I-67). The nutrient tonnage in Table I-67 was converted to product tons in Table I-68.

Projections in product tons for the sector not receiving a subsidy in 1985 are shown in Table I-69.

Total projections for Cameroon were made by combining the projections made for both sectors and are shown in Table I-70 and Figure I-14. The projections from 1985 to 1995 indicate that product tonnage during this period will increase by almost 6% annually. However, during this period the nutrient tonnage implied by these projections will increase by slighty over 6.5% annually as the product mix changes to higher analysis products. Total use of nitrogen will continue to increase faster than that of phosphate or potash although phosphate will have the largest percentage increase (Figure I-15).

The tonnage of fertilizer projected by Province is shown in Table I-71 and indicates that the growth area in the future, as it has been in recent years, is the three northern provinces. The slowest growth will be in the East Province which reflects the slow growth in sugar fertilizer consumption. Growth rates in the West Province are very moderate, reflecting the slow growth in fertilizer consumption in coffee and the shift from a very high percentage of ammonium sulfate (21% N--more than half of total consumption in 1984) to high-analysis urea (46% N) in the future. This slow growth in coffee fertilizer consumption is offset by an expanding fertilizer consumption for food crops.

Fertilizer projections by crop are shown in Table I-72. Food crops are expected to increase fertilizer use faster than any other crop (Figure I-16). The projections have assumed that the government plans to seriously emphasize food-crop production during the projection period. An annual growth rate of over 11% annually is projected for the increase in fertilizer use on food crops. Cotton is also increasing in importance of fertilizer use. Sugar use is declining in importance.

Detailed tables concerning fertilizer use by province or provincial groupings and by crops for Scenario I are included in Appendix A.

Scenario II--Projections with Recommended Marketing System and Current Fertilizer/Crop Price Ratios--The basic assumptions for this scenario are described in the Projections Methodology Section under Scenario II. It was assumed that the recommended system would be in place in 1987 but would sell

Table I-67. Scenario I--Projected Consumption of Fertilizer Nutrients 1986-95 (For Agencies Receiving a Subsidy in 1985)

Year	Nitrogen	Phosphate	Potash	Total
	(nutrient mt)			
1981	11,235	1,896	1,870	15,001
1982	12,134	3,658	3,435	19,227
1983	16,442	4,123	3,942	24,507
1984	18,421	5,067	4,920	28,408
1985	14,766	3,414	5,044	23,224
Base	16,543	4,201	4,635	25,379
	(projected)			
1986	17,536	4,453	5,573	27,562
1987	18,588	4,720	5,140	28,448
1988	19,702	5,003	5,003	29,708
1989	20,884	5,304	5,304	31,492
1990	22,138	5,622	5,622	33,382
1991	23,466	5,959	5,959	35,384
1992	24,875	6,317	6,317	37,509
1993	26,367	6,696	6,696	39,759
1994	27,948	7,098	7,098	42,144
1995	29,626	7,523	7,523	44,672

Source: IFDC.

Table I-68. Scenario I--Projected Fertilizer Consumption by Product (For Agencies Receiving a Subsidy in 1985)

Year	AS	20-10-10	12-6-20	Urea	Total
	(product mt)				
1981	28,077	13,778	0	3,655	50,801
1982	23,648	31,305	0	1,589	58,569
1983	37,872	35,915	30	2,475	78,439
1984	36,912	46,417	50	2,667	87,772
1985	15,295	26,818	11,812	10,356	64,332
	(projected)				
1986	15,000	39,729	8,000	11,913	74,642
1987	10,000	45,400	3,000	15,321	73,720
1988	9,000	50,030	0	16,971	76,000
1989	8,000	53,040	0	18,688	79,728
1990	7,000	56,219	0	20,487	83,705
1991	6,000	59,588	0	22,367	87,954
1992	6,000	63,170	0	23,873	93,041
1993	6,000	66,961	0	25,468	98,429
1994	6,000	70,981	0	27,157	104,137
1995	6,000	75,231	0	28,957	110,186

Source: IFDC.

Table I-69. Scenario I--Fertilizer Projected for the Estate Sector

Year	Total Product Tons	Year	Total Product Tons
1981	34,891	1989	52,081
1982	32,007	1990	55,281
1983	37,984	1991	58,738
1984	36,294	1992	62,483
1985	40,724	1993	66,548
1986	43,816	1994	70,967
1987	46,370	1995	75,791
1988	49,117		

Source: IFDC.

Table I-70. Scenario I--Cameroon Projected Total Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	12-6-20	Urea	Rock	DAP	TSP	KCl
	(mt)							
1986	16,126	40,381	8,000	18,555	3,458	1,470	389	9,304
1987	11,181	46,085	3,000	22,277	3,626	1,486	416	9,655
1988	10,238	50,749	0	24,261	3,801	1,503	445	10,022
1989	9,300	53,795	0	26,335	3,986	1,521	476	10,408
1990	8,364	57,012	0	28,515	4,180	1,539	509	10,813
1991	7,431	60,421	0	30,800	4,383	1,558	544	11,238
1992	7,499	64,045	0	32,738	4,596	1,578	581	11,685
1993	7,575	67,880	0	34,794	4,819	1,599	621	12,152
1994	7,651	71,946	0	36,974	5,053	1,621	663	12,642
1995	7,732	76,244	0	39,298	5,299	1,644	708	13,157

Year	Products						
	10-10-20	15-15-15	SSP	KSO_4	15-20-15	22-10-15	Total
	(mt)						
1986	987	4,789	11	11	6,799	8,178	118,458
1987	1,036	5,280	12	12	7,275	8,750	120,090
1988	1,088	5,837	13	13	7,784	9,363	125,117
1989	1,142	6,471	14	14	8,329	10,018	131,809
1990	1,199	7,194	15	15	8,912	10,719	138,986
1991	1,259	8,021	16	16	9,536	11,469	146,692
1992	1,322	8,970	17	17	10,204	12,272	155,524
1993	1,388	10,064	18	18	10,918	13,131	164,977
1994	1,457	11,327	19	19	11,682	14,050	175,104
1995	1,530	12,791	20	20	12,500	15,034	185,977

Year	Nutrients			Total
	N	P_2O_5	K_2O	(mt)
	(mt)			
1986	24,859	9,407	14,388	48,654
1987	26,352	9,979	14,410	50,741
1988	27,942	10,591	14,760	53,293
1989	29,638	11,249	15,582	56,469
1990	31,447	11,954	16,460	59,861
1991	33,376	12,710	17,399	63,485
1992	35,435	13,526	18,405	67,366
1993	37,635	14,404	19,483	71,522
1994	39,984	15,351	20,640	75,975
1995	42,500	16,375	21,883	80,758

Source: IFDC.

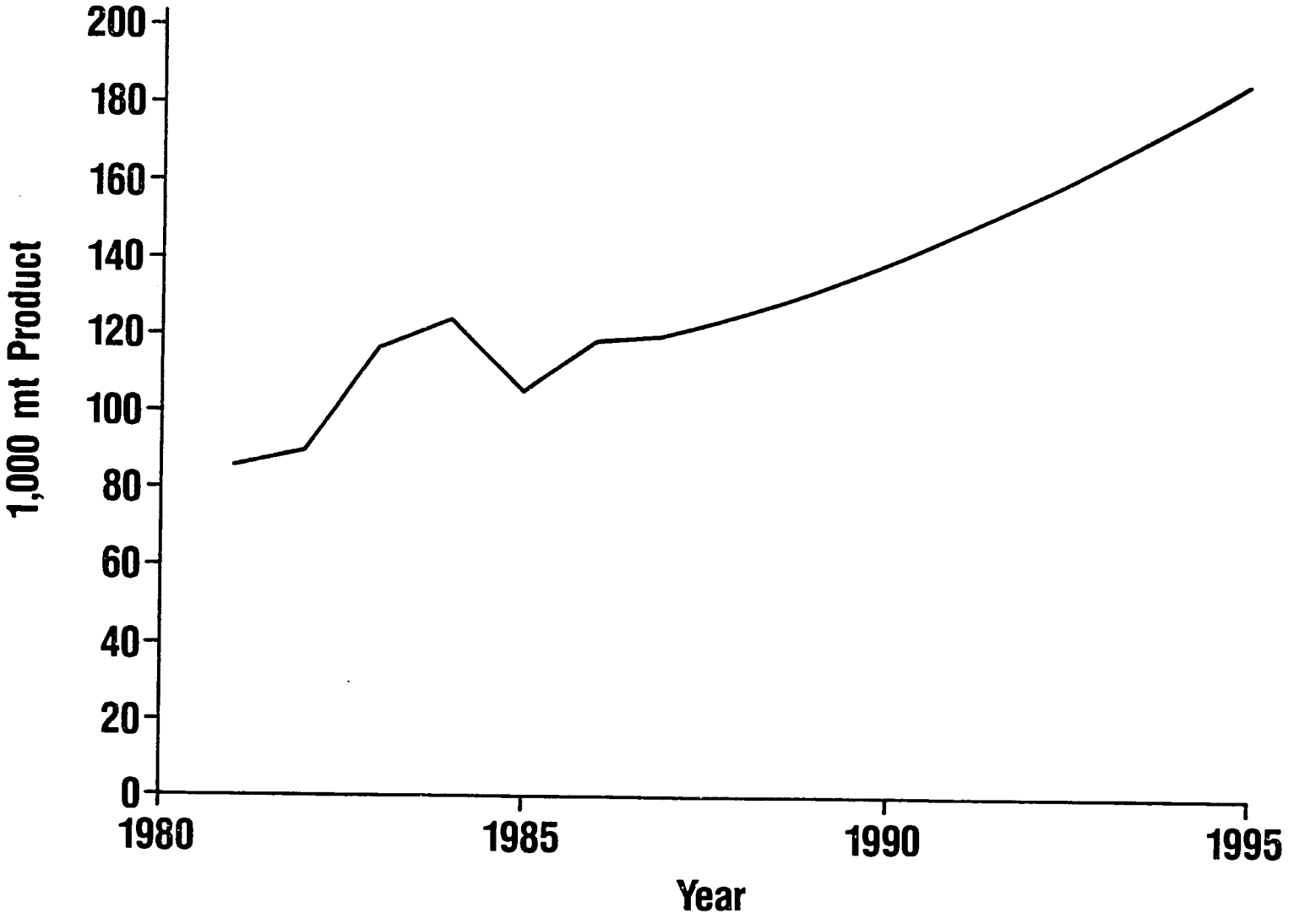


Figure I-14. Cameroon: Fertilizer Product Projections—Scenario I—Present Marketing System and Current Fertilizer/Crop Prices.

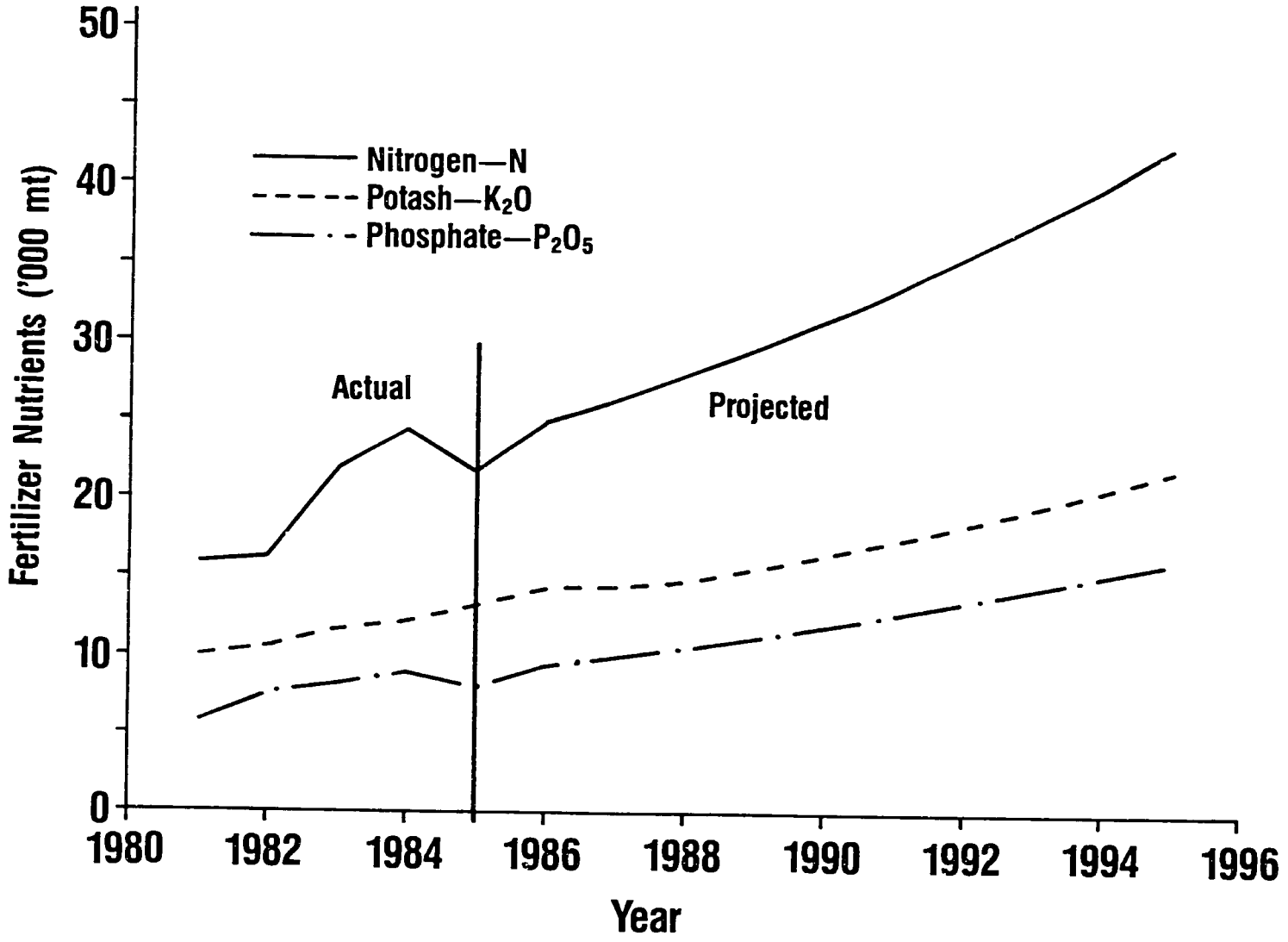


Figure I-15. Cameroon: Fertilizer Nutrient Projections—Present Marketing System and Current Fertilizer/Crop Prices.

Table I-71. Scenario I--Cameroon Total Fertilizer Consumption Projections by Province[a]

Year	Central and South	West[b]	East	Northern	Littoral[b]	South West	North West	Total
	(product mt)							
1981	711	23,316	8,502	17,739	23,193	6,667	5,564	85,692
1982	591	30,276	7,636	17,321	21,955	8,107	4,690	90,576
1983	995	27,087	8,178	22,748	38,679	8,360	10,376	116,423
1984	1,677	35,324	8,818	24,784	33,799	8,725	10,939	124,066
1985	994	20,896	6,480	27,184	36,502	8,272	4,728	105,056
1986	1,317	26,066	7,547	28,957	37,495	8,623	8,453	118,458
1987	1,313	25,792	7,556	30,491	37,722	8,862	8,354	120,090
1988	1,353	26,594	7,643	32,595	39,079	9,241	8,612	125,117
1989	1,426	27,919	7,789	34,900	41,021	9,716	9,038	131,809
1990	1,501	29,332	7,944	37,416	43,083	10,218	9,492	138,986
1991	1,583	30,840	8,110	40,165	45,272	10,746	9,976	146,692
1992	1,677	32,629	8,293	43,273	47,777	11,323	10,552	155,524
1993	1,775	34,522	8,487	46,674	50,424	11,931	11,164	164,977
1994	1,879	36,531	8,691	50,401	53,220	12,569	11,813	175,104
1995	1,989	38,658	8,909	54,500	56,177	13,245	12,499	185,977

a. Based on point of purchase.
b. An estimated 6,000-12,000 mt of fertilizer is purchased each year in the Littoral Province and used in the West Province.

Source: IFDC.

Table I-72. Scenario I--Cameroon Total Fertilizer Projections by Crop

Year	Bananas	Coffee	Cotton	Food Crops	Oil Palm	Rubber	Sugar	Tea	Tobacco	Total
	(product mt)									
1985	2,018	49,073	21,020	16,259	7,720	2,810	5,000	1,101	55	105,054
1986	2,119	56,188	22,491	19,654	8,088	3,702	5,000	1,157	59	118,458
1987	2,225	54,645	24,065	20,515	8,473	3,888	5,000	1,216	63	120,090
1988	2,336	55,294	25,750	22,434	8,876	4,083	5,000	1,277	67	125,117
1989	2,453	56,969	27,553	24,833	9,301	4,288	5,000	1,341	71	131,809
1990	2,577	58,712	29,482	27,482	9,747	4,502	5,000	1,409	75	138,986
1991	2,706	60,533	31,545	30,408	10,213	4,728	5,000	1,480	79	146,692
1992	2,842	62,747	33,753	33,878	10,703	4,964	5,000	1,554	83	155,524
1993	2,984	65,021	36,116	37,707	11,216	5,212	5,000	1,632	87	164,977
1994	3,133	67,351	38,643	41,947	11,753	5,473	5,000	1,713	91	175,104
1995	3,290	69,735	41,349	46,644	12,318	5,747	5,000	1,799	95	185,977

Source: IFDC.

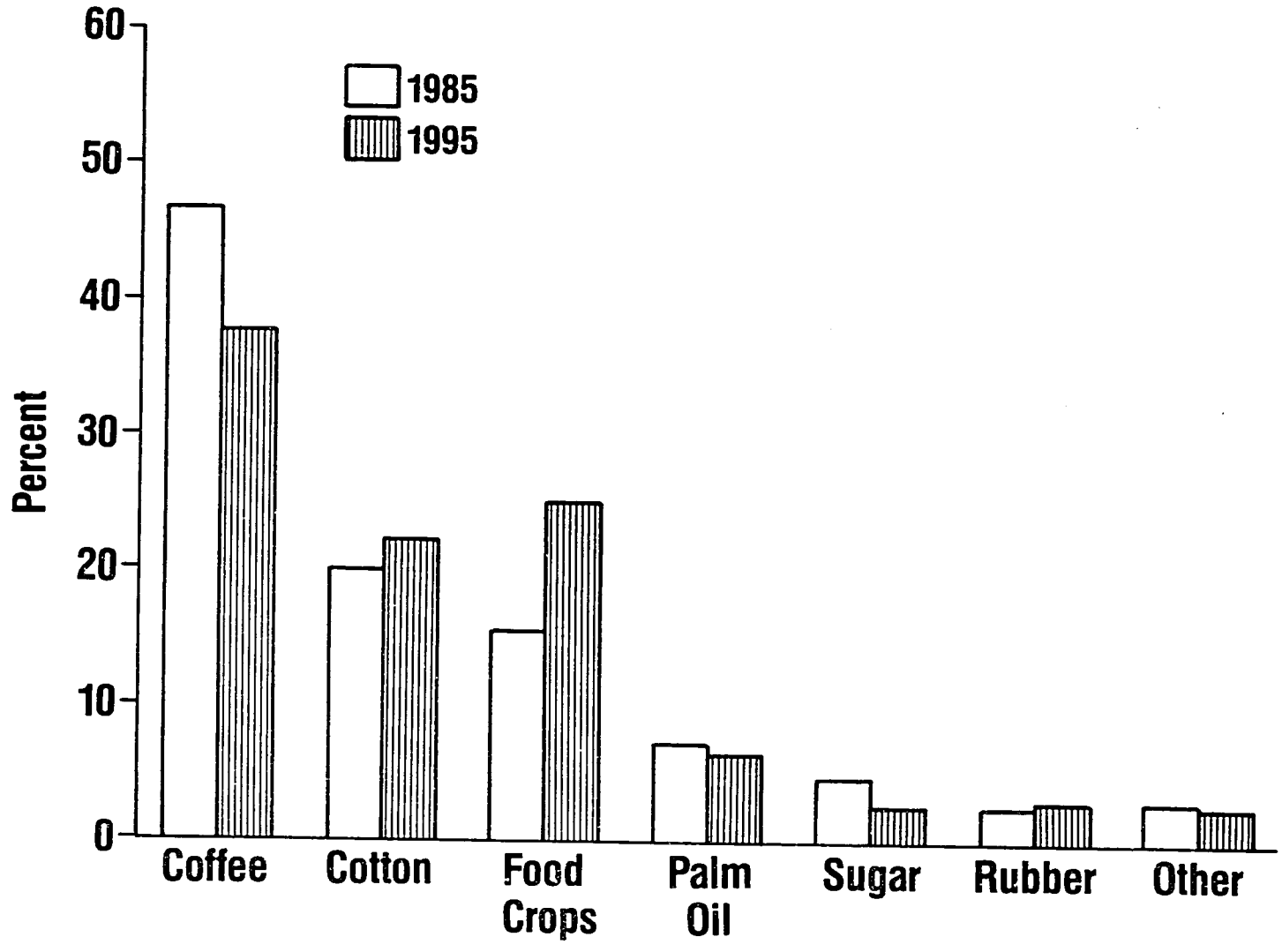


Figure I-16. Percent of Total Fertilizer Used by Major Crops—Scenario I—Present Marketing System With Current Fertilizer/Crop Price Ratios.

only 6,000 mt that year, which would only replace tonnage that would have been sold by the old system. Thus tonnage in 1985 is the same with both systems (Table I-73). It was also assumed that the impact of this new system would be on the sector that was subsidized in 1985 because the estate sector is currently fertilizing at recommended rates with appropriate products.

The new system will promote sales of 10-30-10, a high-phosphate fertilizer, particularly for food crops beginning in 1988. It should be noted that a ton of this fertilizer provides 25% more nutrients than does a ton of 20-10-10. However an aggressive dealer-oriented marketing system designed to promote the proper use of fertilizer and make it available on a timely basis will also increase the total product tonnage of fertilizer used. A comparison of the tonnage to be sold with and without the present marketing system is shown in Table I-73 both on a total product and total nutrient basis.

Although differences in projections are not significantly different in the early years with the recommended marketing system, the differences become substantial in future years. For example, by 1995 more than 25% more nutrients will be supplied by the recommended system. Product tonnage will increase by about 20% However, in the early years the small differences in tonnage are somewhat misleading in that phosphate and nitrogen, which are badly needed, are being increased substantially, whereas potash, which is not needed as badly, is not. Thus, a more appropriate product mix is being delivered. The average nutrient content with the recommended system is also slightly higher.

Total projected consumption for 1986-95 by product for the sector which was subsidized in 1985 is shown in Table I-74. These figures represent about an 8% growth in product tonnage and a 9% growth in nutrient tonnage from 1985 to 1995. This table illustrates how 10-30-10 and urea are replacing the increase in 20-10-10 shown in the projections for the current marketing system (Scenario I). In that scenario, 75,231 mt of 20-10-10 was projected to be used. In this scenario with the recommended marketing system, 40,000 mt of 10-30-10 is projected to be used and only 45,750 mt of 20-10-10. Total use projected for Cameroon by product and nutrient is shown in Table I-75.

Detailed tables concerning projected fertilizer use by regions and by crops under this scenario are included in Appendix B.

Scenario III--Projections With Present Marketing System and High Fertilizer/Crop Price Ratios--The basic assumptions and methodology for this section are described in the Projections Methodology Section under Scenario III.

Table I-73. Scenario II--Cameroon Comparison of Projected Total Fertilizer Consumption with the Present Marketing System and the Recommended Marketing System With Current Fertilizer/Crop Price Ratios

Year	Total Product Tons		Total Nutrient Tons	
	Present (Scenario I)	Recommended[a] (Scenario II)	Present (Scenario I)	Recommended[a] (Scenario II)
1986	118,458	118,458	48,654	48,654
1987	120,090	120,090	50,741	50,741
1988	125,117	126,022	53,293	54,277
1989	131,809	134,542	56,469	58,792
1990	138,986	144,641	59,861	63,939
1991	146,692	156,548	63,485	69,807
1992	155,524	171,053	67,366	76,491
1993	164,977	187,005	71,522	83,908
1994	175,104	203,827	75,975	91,985
1995	185,977	222,832	80,758	101,080

a. Recommended system will not affect consumption until 1988.

Source: IFDC.

Table I-74. Scenario II--Subsidized Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	20-10-10	12-6-20	10-30-10	Urea	
	(mt)					(mt)
1986	15,000	39,729	8,000	0	11,913	74,642
1987	10,000	45,400	3,000	0	15,321	73,720
1988	8,999	43,233	0	4,000	20,674	76,905
1989	8,000	40,622	0	8,000	25,841	82,461
1990	6,999	39,599	0	12,000	30,762	89,360
1991	5,999	40,450	0	16,000	35,359	97,810
1992	5,998	43,490	0	20,000	39,082	108,570
1993	6,000	46,079	0	25,000	43,377	120,457
1994	5,999	45,670	0	32,000	49,191	132,860
1995	5,998	45,750	0	40,000	55,293	147,041

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	17,536	4,453	5,573	27,562
1987	18,588	4,720	5,140	28,448
1988	20,446	5,523	4,723	30,692
1989	22,491	6,462	4,862	33,815
1990	24,740	7,560	5,160	37,460
1991	27,215	8,846	5,645	41,706
1992	29,935	10,349	6,349	46,633
1993	32,929	12,108	7,108	52,145
1994	36,222	14,167	7,767	58,156
1995	39,844	16,575	8,575	64,994

Source: IFDC.

Table I-75. Scenario II--Cameroon Projected Total Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	12-6-20	10-30-10	Urea	Rock	DAP	TSP
	(mt)							
1986	16,126	40,381	8,000	0	18,555	3,458	1,470	389
1987	11,181	46,085	3,000	0	22,277	3,626	1,486	416
1988	10,238	43,952	0	4,000	27,964	3,801	1,503	445
1989	9,300	41,377	0	8,000	33,488	3,986	1,521	476
1990	8,364	40,392	0	12,000	38,790	4,180	1,539	509
1991	7,431	41,283	0	16,000	43,792	4,383	1,558	544
1992	7,499	44,365	0	20,000	47,947	4,596	1,578	581
1993	7,575	46,998	0	25,000	52,703	4,819	1,599	621
1994	7,651	46,635	0	32,000	59,008	5,053	1,621	663
1995	7,732	46,763	0	40,000	65,634	5,299	1,644	708

Year	Products							Total
	KCl	10-10-20	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)							(mt)
1986	9,304	987	4,789	11	11	6,799	8,178	118,458
1987	9,655	1,036	5,280	12	12	7,275	8,750	120,090
1988	10,022	1,088	5,837	13	13	7,784	9,363	126,022
1989	10,408	1,142	6,471	14	14	8,329	10,018	134,542
1990	10,813	1,199	7,194	15	15	8,912	10,719	144,641
1991	11,238	1,259	8,021	16	16	9,536	11,469	156,548
1992	11,685	1,322	8,970	17	17	10,204	12,272	171,053
1993	12,152	1,388	10,064	18	18	10,918	13,131	187,005
1994	12,642	1,457	11,327	19	19	11,682	14,050	203,827
1995	13,157	1,530	12,791	20	20	12,500	15,034	222,832

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	24,859	9,407	14,388	48,654
1987	26,352	9,979	14,410	50,741
1988	28,686	11,111	14,480	54,277
1989	31,245	12,407	15,140	58,792
1990	34,049	13,892	15,998	63,939
1991	37,125	15,597	17,085	69,807
1992	40,496	17,558	18,437	76,491
1993	44,197	19,816	19,895	83,908
1994	48,257	22,420	21,308	91,985
1995	52,718	25,427	22,935	101,080

Source: IFDC.

Basically the same methodology was used as in Scenario I (Projections with Present Marketing System and Current Fertilizer/Crop Price Ratios) except that it was assumed that even though crop prices would likely increase slightly, they would not offset the large increase in fertilizer prices as the subsidy is removed over the next 5 years.

Sales for 1986 were projected to be the same with both scenarios because no major changes in prices were assumed to occur. The projections indicate that total product tonnage would not reach 1986 levels until 1990 as a result of the unfavorable price relationships. Nutrient and product tonnage in 1995 with high fertilizer/crop price ratios would be about 20% lower than with current ratios (Table I-76).

Total consumption by product for the sector that was subsidized in 1985 is shown in Table I-77. This table illustrates how use of all products would be reduced. Table I-78 shows the same for all fertilizer comsumed in Cameroon. However, because the estate sector is currently not subsidized, little change in the consumption of this sector would occur under this scenario.

Detailed tables concerning projected fertilizer use by regions and by crops under this scenario are included in Appendix C.

Scenario IV--Projections With Recommended Marketing System and High Fertilizer/Crop Price Ratios--The basic assumptions for this scenario are described in the Projections Methodology Section under Scenario IV. Basically the same methodology was used as in Scenario II (Projections with Recommended Marketing System and Current Fertilizer/Crop Price Ratios) except that it was assumed that even though crop prices would increase, they would not offset the large increases in fertilizer prices as the subsidy is removed over the next 5 years.

Sales for 1986 were projected to be the same as with the present system and current price relationships. Sales for 1987 were projected to be the same as with the present system and high price relationships (Scenario III) because the recommended marketing system is not expected to affect consumption until 1988 (Table I-79).

On the basis of the high price ratios and the present marketing system, consumption in 1995 would be 190,440 product mt versus 147,156 product mt, or roughly 29% higher. However, consumption is projected to be about 32,400 product mt lower than it would have been with the recommended system and current fertilizer/crop price relationships.

Table I-76. Scenario III--Comparison of Projected Total Fertilizer Consumption With the Present Marketing System and Current and High Fertilizer/Crop Price Ratios

Year	Total Product Tons		Total Nutrient Tons	
	Current Ratios (Scenario I)	High Ratios (Scenario III)	Current Ratios (Scenario I)	High Ratios (Scenario III)
1986[a]	118,458	118,458	48,654	48,654
1987	120,090	113,392	50,741	47,911
1988	125,117	113,814	53,293	48,548
1989	131,809	117,080	56,469	50,277
1990	138,986	120,636	59,861	52,137
1991	146,692	124,508	63,485	54,140
1992	155,524	129,595	67,366	56,451
1993	164,977	135,049	71,522	58,926
1994	175,104	140,888	75,975	61,576
1995	185,977	147,156	80,758	64,422

a. Price ratios in 1986 were assumed to be the same under both scenarios.

Source: IFDC.

Table I-77. Scenario III--Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios (for Agencies Receiving a Subsidy in 1985)

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	15,000	39,729	8,000	11,913	74,642
1987	10,000	41,218	3,000	12,865	67,082
1988	9,000	42,485	0	13,354	64,838
1989	8,000	43,379	0	13,869	65,248
1990	7,000	44,331	0	14,415	65,745
1991	6,000	45,351	0	14,993	66,343
1992	6,000	46,446	0	15,476	67,920
1993	6,000	47,617	0	15,993	69,610
1994	6,000	48,869	0	16,543	71,411
1995	6,000	50,205	0	17,133	73,336

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	17,536	4,453	5,573	27,562
1987	16,621	4,302	4,722	25,645
1988	16,530	4,249	4,249	25,028
1989	16,736	4,338	4,338	25,412
1990	16,967	4,433	4,433	25,833
1991	17,227	4,535	4,535	26,297
1992	17,668	4,645	4,645	26,958
1993	18,140	4,762	4,762	27,664
1994	18,643	4,887	4,887	28,417
1995	19,182	5,021	5,021	29,224

Source: IFDC.

Table I-78. Scenario III--Cameroon Projected Total Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	12-6-20	Urea	Rock	DAP	TSP	KCl
	(mt)							
1986	16,126	40,381	8,000	18,555	3,458	1,470	389	9,304
1987	11,181	41,903	3,000	19,821	3,626	1,486	416	9,655
1988	10,238	43,204	0	20,644	3,801	1,503	445	10,022
1989	9,300	44,134	0	21,516	3,986	1,521	476	10,408
1990	8,364	45,124	0	22,443	4,180	1,539	509	10,813
1991	7,431	46,184	0	23,426	4,383	1,558	544	11,238
1992	7,499	47,321	0	24,341	4,596	1,578	581	11,685
1993	7,575	48,536	0	25,319	4,819	1,599	621	12,152
1994	7,651	49,834	0	26,360	5,053	1,621	663	12,642
1995	7,732	51,218	0	27,474	5,299	1,644	708	13,157

Year	Products						Total
	10-10-20	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)						(mt)
1986	987	4,789	11	11	6,799	8,178	118,458
1987	1,036	5,220	12	12	7,275	8,750	113,392
1988	1,088	5,696	13	13	7,784	9,363	113,814
1989	1,142	6,222	14	14	8,329	10,018	117,080
1990	1,199	6,804	15	15	8,912	10,719	120,636
1991	1,259	7,448	16	16	9,536	11,469	124,508
1992	1,322	8,162	17	17	10,204	12,272	129,595
1993	1,388	8,955	18	18	10,918	13,131	135,049
1994	1,457	9,837	19	19	11,682	14,050	140,888
1995	1,530	10,820	20	20	12,500	15,034	147,156

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	24,859	9,407	14,388	48,654
1987	24,376	9,552	13,983	47,911
1988	24,748	9,816	13,984	48,548
1989	25,452	10,246	14,579	50,277
1990	26,218	10,706	15,213	52,137
1991	27,050	11,201	15,889	54,140
1992	28,107	11,732	16,612	56,451
1993	29,241	12,303	17,382	58,926
1994	30,455	12,916	18,205	61,576
1995	31,760	13,577	19,085	64,422

Source: IFDC.

Table I-79. Comparison of Projected Total Fertilizer Consumption With the Four Scenarios

	Current Fertilizer/Crop Price Ratios		High Fertilizer/Crop Price Ratios	
	Current System Scenario I	Recommended System Scenario II	Current System Scenario III	Recommended System Scenario IV
	(total product mt)			
1986[a]	118,458	118,458	118,458	118,458
1987[b]	120,090	120,090	113,392	113,392
1988	125,117	126,022	113,814	118,248
1989	131,809	134,542	117,080	124,035
1990	138,986	144,641	120,636	131,261
1991	146,692	156,548	124,508	140,118
1992	155,524	171,053	129,595	151,999
1993	164,977	187,005	135,049	163,836
1994	175,104	203,827	140,888	176,317
1995	185,977	222,832	147,156	190,440

a. Price ratios in 1986 are the same with all four scenarios.
b. Recommended marketing system will not affect total consumption until 1988.

	Current Fertilizer/Crop Price Ratios		High Fertilizer/Crop Price Ratios	
	Current System Scenario I	Recommended System Scenario II	Current System Scenario III	Recommended System Scenario IV
	(total nutrient mt)			
1986[a]	48,654	48,654	48,654	48,654
1987[b]	50,741	50,741	47,911	47,911
1988	53,293	54,277	48,548	50,867
1989	56,469	58,792	50,277	54,057
1990	59,861	63,939	52,137	57,830
1991	63,485	69,807	54,140	62,258
1992	67,366	76,491	56,451	67,718
1993	71,522	83,908	58,926	73,210
1994	75,975	91,985	61,576	79,211
1995	80,758	101,080	64,422	85,971

a. Price ratios in 1986 are the same with all four scenarios.
b. Recommended marketing system will not affect total consumption until 1988.

Source: IFDC.

Total consumption by product for the sector that was subsidized in 1985 is shown in Table I-80. This table illustrates how use of all products would be reduced in comparison with the recommended system and present fertilizer/crop price relationships. However, use is considerably above the level projected in Scenario III with the present system and high prices. Table I-81 presents these data for all fertilizer consumed in Cameroon. Again, very little change is projected in the estate sector under this scenario.

Detailed tables concerning projected fertilizer use by regions and by crops under this scenario are shown in Appendix D. Figure I-17 illustrates the difference in the four scenarios.

Table I-80. Scenario IV--Subsidized Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios (for Agencies Receiving a Subsidy in 1985)

Year	Products				Total
	AS	20-10-10	10-30-10	Urea	
	(mt)				(mt)
1986	15,000	39,729	8,000[a]	11,913	74,642
1987	10,000	41,218	3,000[a]	12,865	67,082
1988	9,000	39,627	2,689	17,957	69,272
1989	8,000	37,276	5,390	21,537	72,203
1990	7,000	36,306	8,106	24,959	76,370
1991	6,000	36,950	10,832	28,172	81,953
1992	6,000	39,467	13,567	31,292	90,324
1993	6,000	41,586	16,997	33,814	98,397
1994	6,000	41,135	21,802	37,904	106,840
1995	6,000	41,102	27,311	42,209	116,620

a. 12-6-20.

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	17,536	4,453	5,573	27,562
1987	16,621	4,302	4,722	25,645
1988	18,344	4,769	4,232	27,345
1989	19,581	5,345	4,267	29,193
1990	21,023	6,062	4,441	31,526
1991	22,692	6,945	4,778	34,415
1992	24,904	8,017	5,303	38,224
1993	26,831	9,258	5,858	41,947
1994	29,103	10,654	6,294	46,051
1995	31,627	12,304	6,841	50,772

Source: IFDC.

Table I-81. Scenario IV--Cameroon Projected Total Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	10-30-10	Urea	Rock	DAP	TSP	KCl
	(mt)							
1986	16,126	40,381	8,000[a]	18,555	3,458	1,470	389	9,304
1987	11,181	41,903	3,000[a]	19,821	3,626	1,486	416	9,655
1988	10,238	40,346	2,689	25,247	3,801	1,503	445	10,022
1989	9,300	38,031	5,390	29,184	3,986	1,521	476	10,408
1990	8,364	37,099	8,106	32,987	4,180	1,539	509	10,813
1991	7,431	37,783	10,832	36,605	4,383	1,558	544	11,238
1992	7,499	40,342	13,567	40,157	4,596	1,578	581	11,685
1993	7,575	42,505	16,997	43,140	4,819	1,599	621	12,152
1994	7,651	42,100	21,802	47,721	5,053	1,621	663	12,642
1995	7,732	42,115	27,311	52,550	5,299	1,644	708	13,157

a. 12-6-20.

Year	Products						Total
	10-10-20	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)						(mt)
1986	987	4,789	11	11	6,799	8,178	118,458
1987	1,036	5,220	12	12	7,275	8,750	113,392
1988	1,088	5,696	13	13	7,784	9,363	118,248
1989	1,142	6,222	14	14	8,329	10,018	124,035
1990	1,199	6,804	15	15	8,912	10,719	131,261
1991	1,259	7,448	16	16	9,536	11,469	140,118
1992	1,322	8,162	17	17	10,204	12,272	151,999
1993	1,388	8,955	18	18	10,918	13,131	163,836
1994	1,457	9,837	19	19	11,682	14,050	176,317
1995	1,530	10,820	20	20	12,500	15,034	190,440

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			
1936	24,859	9,407	14,388	48,654
1987	24,376	9,552	13,983	47,911
1988	26,563	10,337	13,967	50,867
1989	28,297	11,252	14,508	54,057
1990	30,273	12,336	15,221	57,830
1991	32,516	13,610	16,132	62,258
1992	35,343	15,104	17,271	67,718
1993	37,932	16,799	18,479	73,210
1994	40,915	18,684	19,612	79,211
1995	44,205	20,860	20,906	85,971

Source: IFDC.

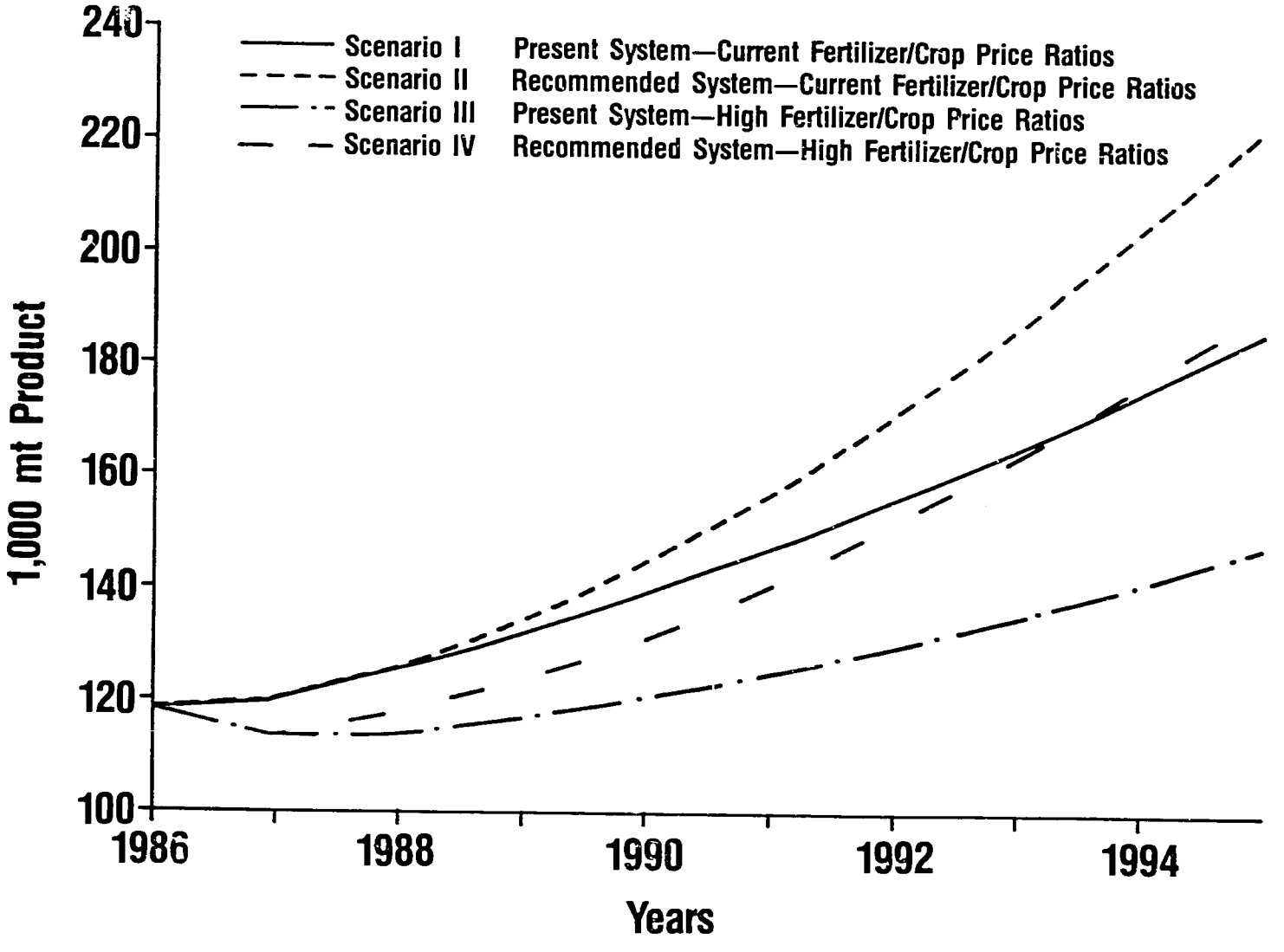


Figure I-17. Cameroon Fertilizer Projections With Various Scenarios.

SECTION II
FERTILIZER MARKETING IN CAMEROON

Apart from the SODECOTON contract farmers, two types of fertilizer consumers exist in Cameroon: large estates or those with centrally managed crop production systems and individual farmers who produce food and cash crops, often intermixed, on small areas. The estates select their fertilizer products, provide for procurement and distribution, and meet their own research needs. Fertilizers handled by the estates are nonsubsidized. Furthermore, the estates operate at no direct cost to the GOC other than their use of foreign exchange. The smallholders, on the other hand, often do not have any appropriate fertilizer available, do not receive fertilizer when they need it, or do not know what or how much of each nutrient to apply for optimum economic production under their soil and crop conditions. The farmers often are not close to markets, and they do not have sufficient funds to purchase fertilizers. To encourage production of coffee by small farmers, the GOC introduced fertilizer subsidies. As the need for fertilizers has increased, the burden of these subsidies has limited the amount of fertilizers that can be delivered for use by the individual farmers.

There is need to establish an efficient marketing system integrating product selection, pricing, promotion, and distribution to service these individual subsidized farmers at the lowest possible cost and to reduce the subsidy burden to the GOC. The successful introduction of an integrated marketing system will hinge, in part, upon establishment of favorable benefit/cost ratios for farmer crops. Furthermore, the marketing system should utilize research to determine the best product mix for crops and should complement the extension service in transferring fertilizer technology to the farmers. The system should determine the best supply of products and utilize the most cost-efficient distribution system for reaching farmers. A retail network linking the marketing system to farmers should be utilized.

The objective of the recommended fertilizer marketing system is to gradually transfer the marketing functions from public institutions to a self-supporting system guided by a profit motive, which will expand fertilizer consumption at the lowest possible cost. Because the recommended system can be self-sufficient, it can reduce the present fertilizer cost to the GOC. By eliminating the constraints to fertilizer use, the system will encourage the farmers to use fertilizers correctly and thus increase crop yields.

The recommended marketing system is directed toward reforming the current subsidized system. It must be phased into operation over a 5-year period. Phase I represents a pilot operation during which the present government subsidy continues. During this phase, staff must be recruited and trained. The system will gain momentum and by Phase V will be fully operational.

As the system is phased in, the present subsidized distribution system will decrease in importance. The decrease in the current system is in direct correlation with the proposed expansion of the recommended system. It is envisioned that, by the end of Phase V, the new recommended marketing system will commence to sell fertilizer in the present nonsubsidized sector. During the phasing periods, new forms and types of fertilizers will be introduced. The recommended new forms and types of fertilizers are based on the farmers' acceptance of the products recommended in the new marketing system and the finding of the supply scheme study presented in Section III.

Evaluation of Present Fertilizer Marketing and Distribution System

In the evaluation of the present fertilizer distribution system it is necessary to examine its methods of operation and describe the organization by functions, identify and analyze constraints to fertilizer use, and make recommendations for overcoming the constraints.

Organization

The present fertilizer system in Cameroon can more accurately be described as a distribution network rather than a complete marketing system. The system does not fully perform the basic marketing functions of product selection, place utility (physical distribution), pricing, and promotion. The system is involved essentially in purchasing and physical distribution. The present system can be illustrated by conceptualizing the organizational structure and relationships in diagram form and by describing the channels used for the functions that are performed. The present system can be divided into procedures for subsidized (Figure II-1) and nonsubsidized (Figure II-2) fertilizers: The light lines indicate the communication or information flows, and the heavy lines indicate the physical movement of fertilizer. Organizational functions are discussed below.

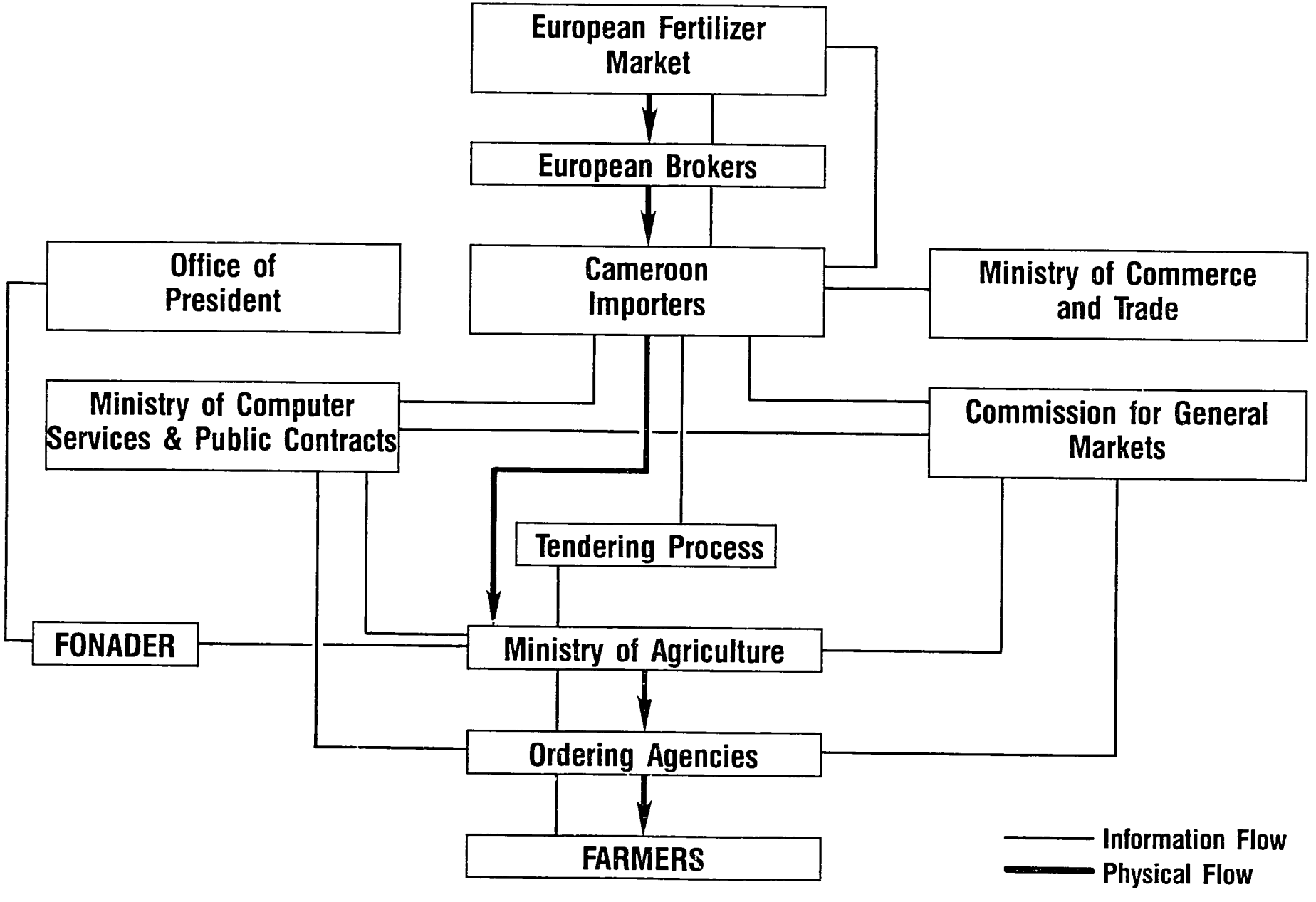


Figure II-1. The Present Organizational Structure for Ordering and Distributing Subsidized Fertilizers in Cameroon.

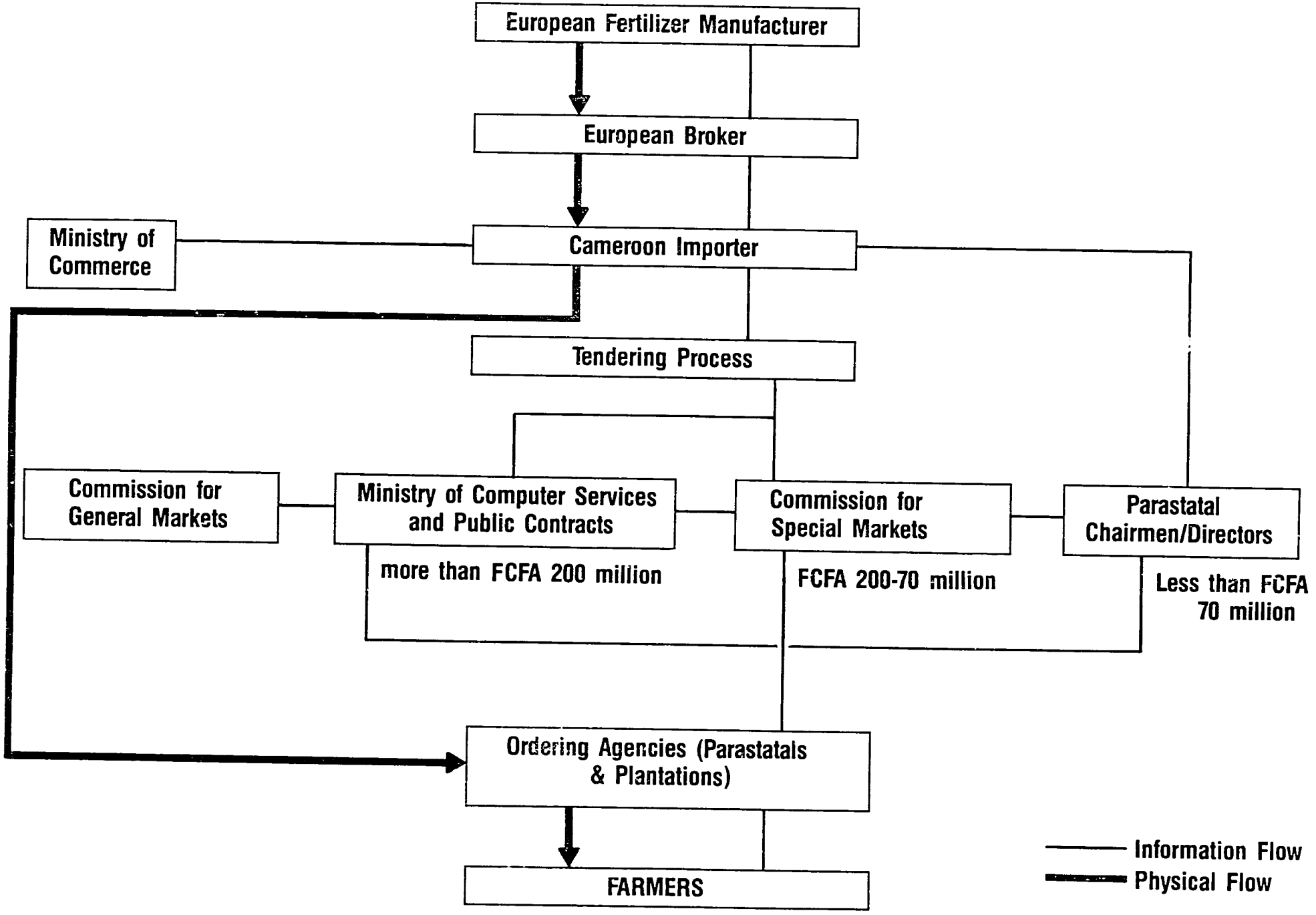


Figure II-2. Present Organizational Structure for Ordering and Distributing Nonsubsidized Fertilizer.

Originally the subsidized fertilizer program was intended to increase coffee production, particularly by the small-holder sector. In recent years subsidized fertilizers have also been directed toward food crops. These fertilizers are controlled by the Ministry of Agriculture and the funding source--the Office of the President through FONADER. Nonsubsidized fertilizers are used by plantations and parastatals producing export crops. For nonsubsidized fertilizers, the Ministry of Agriculture is not directly involved, and the controlling agencies are the Ministry of Computer Services and Public Contracts, the Commission for Special Markets, and the Commission for General Markets. In both procedures the communications are carried out among the consumer, the ordering agency, the controlling agency, the importers in Cameroon or Europe, and the European manufacturer.

Products

The principal fertilizer products presently being offered for sale in Cameroon and the crops for which they are directed are discussed in the agronomic section. Changes required for a more appropriate fertilizer are also given in that section.

One of the important functions performed by an effective fertilizer marketing system is to determine the most appropriate fertilizer for the farmer customers it supplies. The selection of products to be offered farmers should be based on the latest fertilizer research findings. An effective fertilizer marketing system will work closely with all research facilities to obtain accurate data. The system should identify and encourage research.

The present distribution system for subsidized fertilizers, with the exception of SEMRY which started receiving subsidized fertilizers in 1985, has not used research findings in selecting fertilizers. In the past, subsidized fertilizers have been mainly 20-10-10 and ammonium sulfate for coffee. These products--primarily because of their availability and, to some degree, price--have become widely used for food crops. The use of these products on such a wide basis has been a fault of the distribution system for subsidized fertilizers. Fertilizer products supplied farmers by SEMRY are based on their own research findings.

The distribution system for nonsubsidized fertilizers overall appears to deliver fertilizer materials that are based on research findings. Fertilizer practices for estate crops, oil palm, rubber, banana, and pineapple are based on internationally accepted soil and plant tissue analysis techniques.

The recommendations for fertilizers on soils used to produce cotton result from the close liaison between the French research groups and SODECOTON.

The recommendation for soils that are used to grow Arabica and Robusta coffee have been studied for many years. With the application of good management practices, the current recommendations are appropriate. However, urea with its lower cost per kilogram of nitrogen could be substituted for AS in most cases.

The present distribution system for subsidized fertilizers is not able to help force the changes in the product slate that are necessary and to encourage proper fertilizer use. In the systems for both subsidized and nonsubsidized fertilizers, products are dictated to the farmers and to specific projects. This results in a limited range of available products.

Pricing

In the existing fertilizer system there are two different pricing policies. One policy covers subsidized fertilizer that is handled exclusively by the Ministry of Agriculture/FONADER, which is intended to serve the traditional small coffee-growing farmer. Another policy covers nonsubsidized fertilizers handled by the large farming sector, private plantations, and parastatals.

Under the subsidized system, the government determines a single official price for all types of fertilizer. In 1985, for example, a uniform price was set at FCFA 40,000/mt (US $100/mt) or FCFA 2,000/50-kg bag (US $5.00/50-kg bag). This means that regardless of distance to farms, nutrient content, and cost of product, all subsidized fertilizers have the same retail price. A bag of ammonium sulfate containing 21% nitrogen costs the farmer the same amount as a bag of urea containing 46% nitrogen. Subsidized fertilizers are shipped to cooperatives and other ordering agencies on a consignment basis.

The retailers of subsidized fertilizers are allowed a 10% margin. The retailing organizations submit to FONADER FCFA 36,000/mt or FCFA 1,800/bag. They recover the 10% when the fertilizer is sold to farmers at the established price. The study team found some variations in pricing the subsidized fertilizer. The South West Cooperative reportedly was selling some fertilizers on credit to farmers at FCFA 2,050/bag. Some other organizations were selling old stocks of urea at the nonsubsidized price of FCFA 4,567/bag. UCCAO subsidized fertilizer by FCFA 50/bag which results in a farmer price of FCFA 1,950/bag. It appeared that either pricing information had not been passed to all organizations retailing subsidized fertilizers or the pricing policy is not being enforced.

The study team was informed that some traders purchase 50-kg bags from cooperatives and repackage them into small units for resale at prices above the official subsidized price level.

The consultants observed many features in the present fertilizer system that lead to inflated prices or black market trade--both locally and among the western provinces.

Ordering agencies must estimate and request the quantities needed a year in advance. The central purchasing agencies have insufficient funds to fulfill these orders, and their allocation creates general and spot scarcities. The physical distribution methods, the road restrictions on transport, an insufficient number of outlets, and the limited field storage capacity operate to create local shortages and stockouts. At subsidized prices, the effective demand exceeds the supply.

The same grade of fertilizer is sold officially at two prices--subsidized and nonsubsidized--in the same locality. Because their returns are greater on some food crops, many farmers are willing to pay a premium price. For example, a farmer near Foumban was willing to pay FCFA 6,000 per bag of 20-10-10 that he was going to apply for food-crop production.

Farm-level buyers with credit or cash can purchase fertilizers at the subsidized price in excess of their own needs and hold or transport them for sale in another time or place of scarcity for a profit at a higher premium price.

Independent coffee buyers can deliver fertilizer directly to the farm and exchange it for coffee on a barter basis.

Under the nonsubsidized fertilizer system, fertilizers are handled by plantations and parastatals serving the "modern" farm sector outside the Ministry of Agriculture system. The exceptions are SEMRY and a few agencies that have retained the right to import nonsubsidized fertilizers if an adequate supply is not forthcoming through the government supply system.

Under the policy for nonsubsidized fertilizer, prices are set by the ordering agency and are sold to farmers at the cost of the product delivered to the retailers' warehouse. SODECOTON was the largest retailer of nonsubsidized fertilizers in 1985; they marketed 22,000 mt of fertilizer. SODECOTON was selling compound fertilizers to their cotton farmers at FCFA 6,000/50-kg bag when their cost was FCFA 8,000/bag and thus subsidizing the cost by FCFA 2,000/bag. Urea was being sold at their cost of FCFA 6,000/bag. SODECOTON recovers the FCFA 2,000 through an adjustment of the purchase price of cotton that they pay to their farmers.

Most plantations and parastatals are the end user of nonsubsidized fertilizer, and thus the retail pricing mechanism is not a factor.

Promotion

An efficient fertilizer marketing system will have its own promotion programs that are designed specifically to convince farmers to use an appropriate fertilizer in the correct manner for best crop yields. An efficient system will not leave this function exclusively for the extension service. Leaflets and a few demonstrations used in a limited way were the only promotional activities found in the present distribution system.

In the food-crop sector the current fertilizer distribution system does not have enough promotional activites to encourage the proper use of fertilizers by farmers. The IRA station at Bambui has published crop production leaflets on "How to Grow Maize for High Yields," "How to Grow Irish Potatoes for High Yields," "How to Grow Yams for Better Yields," and "How to Dry Maize and Other Grains" (Appendix E). These leaflets are available for the training of extension agents. Extension leaflets found in the field for coffee crops contain the recommended fertilizer, amounts, and time of application. These leaflets indicate that 20-10-10 is recommended for coffee, but they do not indicate nutrients contained in the bag or quantities required to produce a crop. Many farmers have discovered, on their own, the difference in nutrient concentration and sources in fertilizers. When the prices are the same, the farmers are starting to request the higher analysis products, i.e., 20-10-10 instead of 21-0-0 and urea 46% N over ammonium sulfate containing only 21% N. Too few of the crop production leaflets are available to farmers. SODECOTON has prepared leaflets on cotton, rice, sorghum, maize, and cowpea production for use by their field representatives (Appendix E). These leaflets are used only by SODECOTON. Crop production leaflets have not been developed for all crops. Especially missing are leaflets for food-crop production practices. The fertilizer distribution system has not taken the leadership in developing promotional materials.

Leaflets and educational media to cover fertilizers on "what is in the bag," "fertilizer contents," "the role of fertilizers," and "sources of nutrients," for example, were not found.

There appeared to be no use of other important types of promotion activities such as field days, farmer meetings, production contests, retailer agronomic services, billboards and posters, and radio promotion. SEMRY had plots demonstrating nitrogen rates on rice. Most of the other retailers of fertilizers did not have promotional activities in 1985.

The approach to the transfer of technology appears to be based on the production of individual crops. For example, plantations and parastatals have their own education programs for coffee, cotton, and bananas. They are aware of the merit of using the correct fertilizer and the proper applications. They do not depend upon their fertilizer distribution network for support. Plantations direct laborers to carry out proven practices and therefore do not have promotional programs. Food-crop production is not presently covered with promotional activity. Fertilizers are delivered to farmers without accompanying instructions on use. The "Poste Agricole" or agricultural extension agents were not working extensively with retailers of subsidized fertilizers. There is no broad-based national program to transfer crop production technology, including fertilizer use, from the researcher to farmers through the present fertilizer distribution system.

Procurement System

Theoretically the Ministry of Agriculture through its agencies surveys farmers to determine types and amounts of fertilizers required. In actual practice, the ordering agency most often determines the quantity to be requested, and the type is determined on the basis of the official crop fertilizer recommendations.

1. The ordering agencies, i.e., cooperatives, SEMRY, ZAPI-Est, etc., determine their fertilizer needs and submit their requests to the Ministry of Agriculture.
2. The ordering agency signs a contract to receive, store, sell, and pay for the approved quantity of fertilizer to be imported (Appendix F).
3. The request for fertilizer is forwarded to FONADER, which takes the following actions:
   a. Arrange funding and amounts to be used..
   b. Review and approve each agency's fertilizer request.
   c. Request the Ministry of Agriculture to purchase the subsidized fertilizers for which funds are available.
   d. Pay 30% of the fertilizer purchase price to the importers when tender awards are made.

Agencies that purchase nonsubsidized fertilizers obtain approval from the Ministry of Computer Services and Public Contracts, the Commission for Special Markets, or the Parastatal Chairman/Director as per the total value

ordered. Orders having a value in excess of FCFA 200 million are approved by the Ministry of Computer Services and Public Contracts and its agency, the Commission for General Markets. Orders having a value of FCFA 70-200 million are submitted to and approved by the Commission for Special Markets. There is a close working relationship with this commission and the Ministry of Computer Services and Public Contracts. Orders having a value of less than FCFA 70 million can be approved by the Chairman/Director of the requesting parastatal or plantation.

In the present fertilizer system the information flow and exchange required to request, obtain approval for, tender, and purchase fertilizers is unnecessarily complex and time consuming. Figure II-1 with the light line indicates the communication flow required in obtaining subsidized fertilizers. The number of exchanges between government agencies in obtaining approval and funding are not indicated. For subsidized fertilizers there is a minimum of 10 steps to be taken in successfully ordering fertilizers. For nonsubsidized fertilizers, as indicated in Figure II-2, there are only five steps in the information flow for successfully ordering and purchasing fertilizers. It takes approximately three times as long to acquire fertilizer under the subsidized system as it does under the nonsubsidized system.

Tendering and Procurement System

The fertilizer tendering and procurement system is inefficient and time consuming. Some agencies order 1 year in advance so that a supply will be on hand when needed. The present system may be near its capacity as structured. The quantities of fertilizers imported in 1984/85 are shown in Table II-1. After the orders requested have been approved, there are two procedures for the purchase of fertilizers: one for subsidized and one for nonsubsidized products.

Subsidized Fertilizers--The complexity and problems associated with fertilizer ordering, tendering, and distribution have been extensively documented by Elliot Berg (1983), USAID (1985), and others. The process for acquiring fertilizers is unnecessarily complex, inefficient, and expensive. The administration associated with procurement is especially complex. Figure II-1 conceptualizes the procurement process for subsidized fertilizers. Each function is traced through the system so that the complexity can be better understood.

The tendering for fertilizers starts once the quantity to be purchased has been decided. The Contracts Department of the Ministry of Computer Services and Public Contracts develops a national call for tenders and passes it to the Ministry of Agriculture. The Ministry of Agriculture publically announces the

Table II-1. Cameroon Fertilizer Imports in 1984/85

Products	Importer	Quantity (tons)
10-10-20	GAMMA 7	500
	SEPCAE	500
22-10-15 + 5B + 1S	SEPCAE	1,000
15-20-15 + 6B + 1S	SEPCAE	6,000
22-10-15 + 4B + 1S	SEPCAE	7,000
20-10-10	ATICIA	12,000
	SUPERFOS	8,000
12-6-20	SEPCAE	5,000
	WANDA	10,000
DAP (18-46-0)	SEPCAE	1,650
	C.F.C.	400
	GAMMA 7	400
AS (21-0-0-14S)	C.F.C.	300
	SEPCAE	13,500
	DIANA SICAC	7,000
Urea (46-0-0)	WANDA	4,680
	PELLENGET	8,000
	SEPCAE	8,850
Potassium chloride (0-0-60)	GAMMA 7	1,250
	SEPCAE	6,500
Phosphate rock (33%)	SEPCAE	2,000
Kieserite	SEPCAE	750
TSP (0-46-0)	SEPCAE	100
Potassium sulfate (0-0-50)	SEPCAE	200
SSP (0-20-0)	SEPCAE	450
TOTAL		106,030

Source: Societe d'Engrais et de Produits Chimiques d'Afrique Equatoriale (SEPCAE).

tenders. Bid documents are purchased by interested importers for FCFA 200,000 from the Ministry of Computer Services and Public Contracts and the Ministry of Agriculture in Cameroon. The tender documents can also be purchased from Cameroon diplomatic representatives at Paris, Bonn, Brussels, Rome, Moscow, London, Washington, Amsterdam, Peking, Lagos, Ottawa, and Madrid.

The Call for Tender document contains the following information:

1. Definitions and technical specifications.
2. Packing and handling materials and procedures.
3. Price bids in 5,000-mt increments.
4. General conditions for financing, taxes, submission of bids, insurance, and duty rights.
5. Sampling procedures.
6. Bid bond requirements.
7. Payment conditions, stamps, and registration.
8. Penalties.

See Appendix G for a typical fertilizer tender that was issued in 1985.

In evaluating the tender specifications used for the present system, several points were found to be inadequate.

1. The particle size and moisture contents of the fertilizers are not specified.
2. Delivery schedules, shipment sizes, access to berths, demurrage, discharge rates, and inspection schedules are not stipulated.
3. In the case of ammonium sulfate, the free acid and moisture contents are not specified.
4. For compound fertilizers, forms or sources of nutrients (i.e., water soluble, ammoniacal, etc.) are not specified.
5. Analytical methods for physical and chemical analysis to determine nutrient contents are not stipulated.
6. The fabric for the polypropylene outer bags and the test methods for them are not specified.
7. The thickness of the liners and methods of closure are also not specified.
8. Laboratories capable of making the chemical and packaging analysis are not identified.
9. Quantities to be purchased are not stipulated.

Bids are submitted by importers to the contracts office of the Ministry of Computer Services and Public Contracts. The Ministry in cooperation with its

Commission for General Markets analyzes the bids submitted and announces the awards. The award-winning importer goes on the European market and secures a supply of products. The European broker delivers the fertilizer to the Cameroon importer in the Douala port on a c.i.f. basis.

Nonsubsidized Fertilizers--The procedures for purchasing nonsubsidized fertilizers valued at FCFA 200 million and above are similar to those used for purchasing subsidized fertilizers, except that the Ministry of Agriculture is not involved. The firm order is passed directly from the ordering agency to the Ministry of Computer Services and Public Contracts. This Ministry issues a national call for tenders for the fertilizer to be purchased. Importers purchase the tender documents and submit bids to the Ministry Contracts office. The successful importer proceeds to arrange for the fertilizer supplies.

Fertilizer purchases in lots having a value of FCFA 70-200 million are handled by the Commission for Special Markets. The commission requests the Cameroon importers to submit bids to supply the ordered fertilizers. The bids are evaluated and awarded. The fertilizers are arranged from European brokers.

For small orders having a value of less than FCFA 70 million the Chairman or Director of the ordering parastatals can authorize fertilizer purchases directly from importers. The Chairman's office normally will have a working relationship with importers and manufacturers and can select the firm that can best meet conditions of the fertilizer order.

Physical Distribution

The physical movement of fertilizers in the present system is indicated in Figures II-1 and II-2 with a heavy line commencing with the European sources and ending with the farmer. The physical movement is present in summary form in Figure II-3. The physical distribution system is discussed in depth later; however, it should be noted that importers are supplied with a finished prepackaged fertilizer. In the current system, the manufacturer assembles raw materials from various sources, refines them, and combines them into finished products. They are bagged in 50-kg bags and shipped to the Douala port in less than shipload lots for pickup by the ordering agencies. Fertilizers physically move through two channels: subsidized and nonsubsidized. Those fertilizers that are imported for subsidized sale are transferred from the quay storage to a shed operated by MINAGRI in Bonaberi.

Figure II-3. Physical Movement of Fertilizers From Source to Farmers in the Present Marketing System.

The rate of movement of subsidized fertilizers through this warehouse is indicated by the percentage of the 1984/85 quota of each fertilizer that remained in stock on October 15, 1985 (Table II-2).

From these same records, it appears that over 25,000 mt of fertilizer was carried over from prior years.

The nonsubsidized fertilizers are transferred to the importers or ordering agency warehouse after being unloaded from the vessel in the Douala port.

Port Handling--The current pattern of supply is such that quantities of fertilizer are imported on a seasonal basis in less than shipload lots. Some importers prefer to receive fertilizers in lots not exceeding 2,500 mt because of the limited rate of clearance from the docks to their warehouse. The fertilizers are shipped in 50-kg reinforced plastic bags with a 4-mil liner. The products are stored for varying lengths of time on the docks, awaiting transfer. Most importers have sufficient warehouse space under lease for immediate storage of imported fertilizers. The Ministry of Agriculture operates a warehouse or shed in Bonaberi of approximately 40,000-mt capacity from which subsidized fertilizers are dispatched (See Figure II-4 for position of the Bonaberi shed in the Douala port). SEPCAE estimates that if the current supply system continues additional storage capacity for 25,000 mt of fertilizers is needed in the port area.

SOCAME serves as the principal stevedoring firm that off-loads fertilizer cargo from ships at Douala. The largest vessel that can be managed is 10,000 mt with an 8-m draft. SOCAME prefers to receive 5,000-mt vessels that contain only one fertilizer grade. As a part of the off-loading procedure the products are palletized in 1-mt units in the hold of the vessel. Small amounts of fertilizers have been received that were palletized at the supply source with and without plastic "shrink-wrap" covers. The "fertilizer that spills from the broken bags within the hold of the ship is repackaged there prior to being palletized and off-loaded. The pallets are hoisted over the ship side onto the quay in 2-mt units. The current maximum discharge rate is 20.5 metric tons per hour (mtph) and the minimum rate strived for is 11.3 mtph. SOCAME states that fertilizer can be discharged 12 months/year except when it is actually raining. An additional wait of a day or two is frequently encountered for each vessel.

A forklift moves the pallets to an assigned spot on the quay. If the receiver pays about FCFA 610/mt, the fertilizer can be covered. There is also

Table II-2. The Rate at Which Products Move Through the Bonaberi Shed as Shown by Stock Records on October 15, 1985

Products	Quota (mt)	Remaining (%)
Ammonium sulfate	18,000	60
20-10-10	17,313	21
12-6-20	15,000	81
Urea	15,000	71

Source: Bonaberi Shed records.

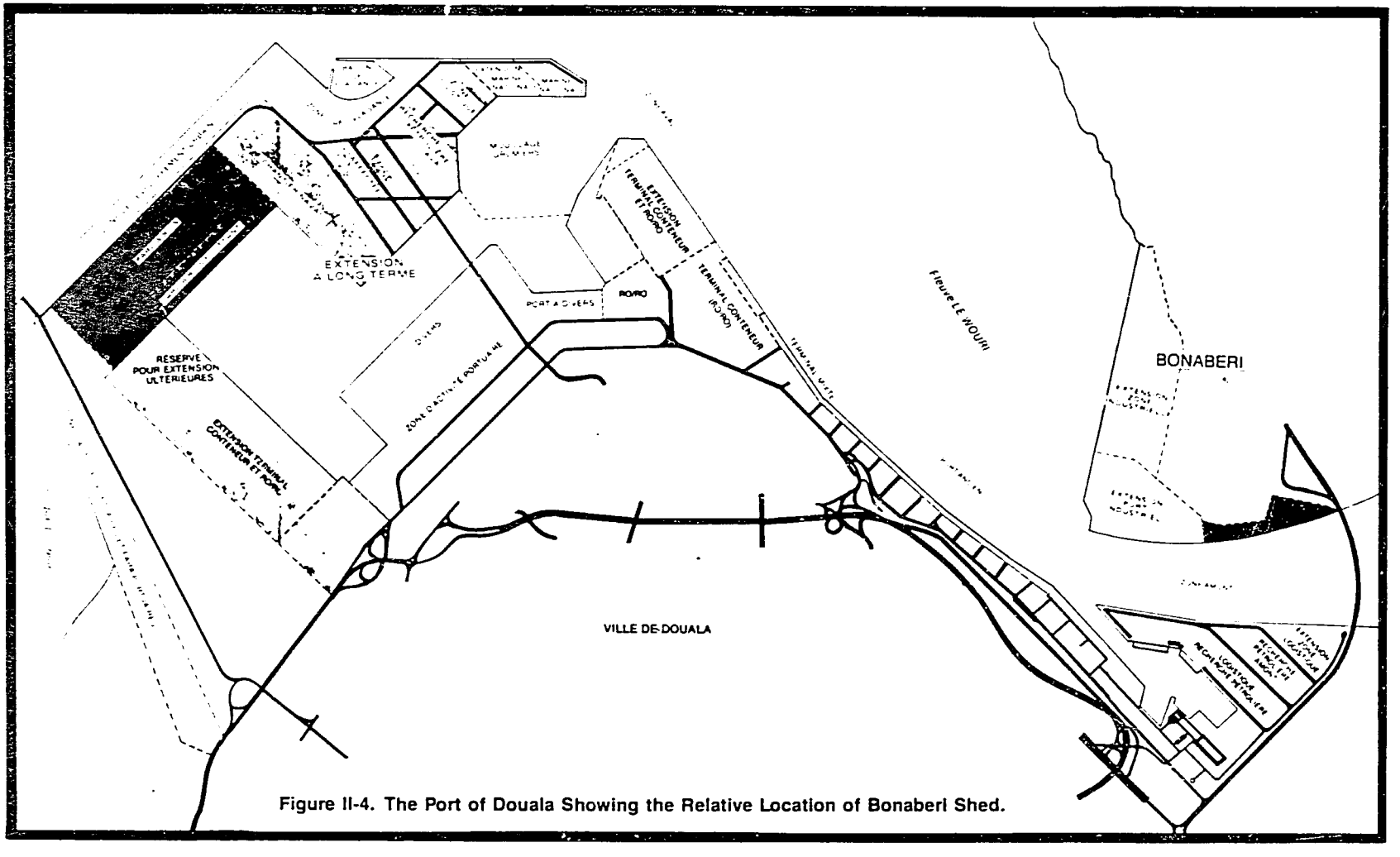


Figure II-4. The Port of Douala Showing the Relative Location of Bonaberi Shed.

an in-transit charge of FCFA 150/mt/day for dockside storage for product left after 11 weather days. The fertilizer is never placed in permanently covered storage while at the docks.

Transport of Fertilizers to Consuming Areas--Loading and shipment into storage in the consuming areas by ordering agencies are carried out in conjunction with a backhaul operation utilizing the agencies' own trucks. The process of hauling crop produce to Douala and taking back fertilizers appears to be economical and preferred from a haulage point of view. The movement of coffee and most other produce to Douala takes place at the end of the dry season. Even if fertilizers are available in Douala at this period, it is too late to build sufficient stocks and distribute to farmers prior to the wet season. There is no apparent urgency to remove the fertilizers from the warehouses. Thus, the offtake pattern is determined by the crop harvest season rather than by a planned fertilizer supply schedule. Importers do charge the ordering agencies for the cost of the fertilizer storage while in their warehouse. Also, those ordering agencies using the Bonaberi shed tend to pick up those specific grades that are part of their quota and for which they have the most pressing current demand. They often leave behind until next year those kinds and amounts of fertilizers that they cannot sell immediately. Usually, nonsubsidized fertilizers are moved to storage in the port area. One exception to this port storage system is the movement of fertilizer by rail in 40-mt wagon lots by SODECOTON to the railhead at Ngaoundere. There, they are transshipped to the 1,000 sales points or are stored.

Because of the seasonal arrival in the port and the urgency of moving the fertilizers to consuming areas to meet planting schedules, the capacity of the truck transport fleet may be exceeded. The primary movement in the subsidized channel is restricted to 40-plus distribution centers. The up-country movement in the nonsubsidized channel is into facilities owned or leased by the firms involved.

Secondary truck transport of subsidized fertilizers within the provinces is carried out in a variety of ways:

1. By the organization-owned vehicles capable of traveling over farm-to-market roads. This is a common practice with parastatals and cooperatives.
2. By private contract haulers.
3. By farmers. The condition of the roads from existing primary distribution centers to the farm dictates movement by cart or head carry. The 1984 Census of Agriculture indicates that about 50% of the farms own some form of transport (Table II-3). Of the farmers owning automobiles and trucks, 68%

Table II-3. Number of Farms Owning Transport by Type of Transport and Province--1984 Agricultural Census

Province	Farms Owning Transport	Type of Transport				
		Bicycle	Motorcycle	Automobile	Truck	Cart
Extreme North	101,300	95,200	17,500	400	300	4,100
North	32,700	29,800	3,900	300	100	4,800
Adamaoua	11,000	6,700	4,000	1,100	200	2,600
East	15,200	10,900	3,600	900	500	2,700
Central	27,600	15,900	9,400	2,800	600	13,400
South	9,600	3,700	5,600	700	200	6,500
Littoral	9,000	4,900	2,200	1,700	600	8,500
South West	14,000	7,000	5,000	3,600	700	8,300
North West	25,400	18,400	4,500	3,500	1,600	400
West	51,600	30,400	19,500	4,700	1,100	24,000
TOTAL	297,400	222,900	75,200	19,700	5,900	75,300

Note: Parts do not sum to total due to multiple counts.

Source: 1984 Census of Agriculture.

are in the Littoral, South West, North West, and West Provinces. Most of the motorcycles and carts are in these areas as well. The availability of over 75,000 carts in Cameroon surely assists the movement of fertilizers to farms. However, such modes of transport serve to constrain the volume of fertilizer used by many farmers.

4. By redirection of primary transport. Some organizations do not take fertilizer transported from the port into their primary warehouses but redirect their own trucks to subdepots or other destinations within their market areas. Thus the secondary transport becomes an extension of the primary movement. The movement of fertilizers on tarred roads can take place on a year-round basis. Secondary and tertiary movement can only take place during the dry season.

The most common form of secondary transport for 1 and 2 above is by two-axle rigid-frame truck carrying about 7 mt. Tertiary movement is done by small vehicles. Freight rates quoted for this secondary transport vary widely.

Transportation is not under the central management of the fertilizer system, and an adequate number of trucks may not be available during rush periods. The resupply time may be so long that demand cannot be met. Such peak seasonal employment can also be quite expensive.

With nonsubsidized fertilizers, many firms arrange for the outbound shipment of their fertilizers to delivery points under their control in their consuming areas. This is especially true for those products handled by SEPCAE. Firms purchasing nonsubsidized fertilizers have adequate storage facilities to meet their needs.

Title Flow--In the subsidized fertilizer system it is not always clear to management as to who actually owns the fertilizer. Title rests with the organization that pays for the fertilizer. When fertilizers are delivered to retailers on consignment, the title remains with the organization that paid for the fertilizers unless otherwise indicated by contractual agreement.

The transfer of title for subsidized fertilizers is made on the following basis:

1. The title for fertilizers passes from the supplier to the importer as per the tendered contract. This is usually c.i.f. Douala.
2. The importer clears customs and ports and passes titles to the Ministry of Agriculture with delivery of the fertilizer to the Bonaberi shed.

3. The Ministry of Agriculture retains title throughout movement and storage and until the fertilizer is sold to farmers.

Title on nonsubsidized fertilizers passes in the following way:

1. Title passes from supplier to Cameroon importers, c.i.f. Douala ports.
2. Title passes from importers to purchasing agency (buyer) at designated Douala warehouses.
3. Some agencies retain title and use the fertilizers, whereas others resell and pass title to farmers.

Payment Flow--Payment for fertilizers closely follows title transfer as it moves through the channels. Payment flow is different for subsidized and nonsubsidized fertilizers.

Under the subsidized program the following arrangements for payment are made:

1. The importer arranges payment to the supplier.
2. Payment to the importer is made by FONADER according to the following conditions:
   a. 30% at the signing of the contract.
   b. 40% upon presentation of the record showing provisional acceptance at each designated delivery place.
   c. 30% balance paid when analysis of product and stipulated packaging are confirmed.

   All payments will be in FCFA through a bank check payable to the contractor.
3. The ordering agency sells the fertilizer to farmers and passes payment to FONADER and withholds a 10% commission (FCFA 4,000/mt).

Under the nonsubsidized program, payments are arranged as follows:

1. The importer arranges payment to the suppliers.
2. Payment is made to the importer by the ordering agency at the designated Douala warehouse where title passes.
3. Some agencies consume the fertilizers, whereas others sell the fertilizers to farmers for cash or on credit. Credit terms are generally offered to farmers through the parastatals, i.e., SODECOTON for cotton production.

Information Flow--The study team found that, because of the complexity and resulting sluggishness of the system, the aggressive marketing organizations for both subsidized and nonsubsidized fertilizers were ordering fertilizers 1 year in advance to ensure a supply.

Examination of records showed that the tonnages of subsidized fertilizer forecast as being required to meet effective demand and the tonnages requested by ordering agencies did not agree. Agencies were ordering more fertilizers than needed because they had learned from past experiences that the amount ordered would be substantially reduced. The quantity approved by the Ministry of Agriculture is dependent upon the available funds allocated by the Office of the President through FONADER. The requesting agencies are then notified as to how much of their requested tonnage has been approved. The kinds and amounts of products finally allocated or even requested may or may not meet the actual demand by farmers. The requesting procedure, with delays in the information flow and time delays in funding, often results in late arrival of fertilizers at the port. The ordering agencies forecast their needs only once per year, which is not often enough for sufficient stock control.

Many of the instruments that are available to inform distribution staff on products were not in use or were not used properly. Evidence of nearly complete documentation was observed at the Bonaberi shed. True bills of lading were not being used. Specific destinations for fertilizer shipments, time of arrival, quantities shipped, and payment methods were not clearly indicated. Bag and truck weights were not cross-checked. Feedback concerning condition of products in shipment and in storage were not made on a scheduled plan. Inventory records at the Bonaberi shed do not indicate quantities of saleable stocks on hand at that site.

Information flow in the nonsubsidized fertilizer sector differs in the following respects:

1. Specific forecasts are made at the farmer level.
2. Orders to meet actual needs are submitted as firm commitments.
3. Close liaison exists between ordering agencies and the procurement system.
4. Most agencies have their own research base which allows direct transfer of appropriate technology.
5. Often fertilizer use information is transmitted more directly to end users by the agency itself.

Current Storage and Warehousing Requirements--Warehousing is involved in four of the five exchange functions: storage, handling, communications, and adjustment. Inventory management is a key factor in a successful warehousing

operation. Because fertilizers are consumed seasonally, the tendency has been to purchase and to stock fertilizers on an annual or seasonal basis. When fertilizers are purchased, larger quantities are bought than can be immediately consumed. This may occur to prevent anticipated shortages or to take advantage of savings resulting from volume purchases. Warehousing space is needed to store the supplies that are temporarily in surplus. Fertilizer warehouses should be both market and supply oriented. The warehouse should be located to serve a market and have enough capacity to fulfill its storage objective.

In Cameroon most warehouses are owned by ordering agencies or rented to them for their convenience. Fertilizers are not stored in bonded or other public facilities. The field warehouses serve as distribution centers.

Because of the "harvest season" orientation of offtake of fertilizers from the port area, the stockage levels in the port are quite high. Certainly, the fertilizers must be stockpiled at some point in the physical distribution channel. In the current system there is a substantial risk during the consuming season of being out of any one product or of being late in delivering a product to any sales point unless sufficient transport is available at that particular time to move the fertilizer. Stock levels are not built as near the farm as possible in advance of use. This requires an improved information system.

More rural retail storage facilities need to be located at selected sites in the sub-districts. More careful central inventory management could substantially reduce the overall national stock level of each product.

Those ordering agencies that receive nonsubsidized fertilizer materials have adequate storage for their purchases. The subsidized fertilizer sector has storage at the sites and in the amounts cited in Table II-4.

The identified field storage capacity of 96,990 mt would appear to be more than adequate for an annual stockage of subsidized fertilizer if it were equally spread around Cameroon. However, it must be noted that 70% or 68,040 mt of this capacity is located in the West Province. Much of it consists of unused coffee warehouses. In 1984/85 the West Province was allocated 18,083 mt of fertilizer or only 27.7% of the total. Littoral Province was allocated 50% or 33,183 mt of the year's fertilizer quota. It had no identified storage other than the Bonaberi shed. On April 10, 1985, when the quotas were fixed, over two-thirds of the Littoral Province allocation remained in stock from previous imports.

Table II-4. Warehouse Storage by Location, Capacity, and Operator

Province	Location	Capacity (mt)	Operator
Adamaoua	Ngaoundere	500	Location
Central	Nkolbissen	500	DIRAGRI
	Bafia	300	SOCOODER
	Monatele	50	SOCOODER
	Evodoula	50	SOCOOPAM
	Obala	50	SOCOOPOB
	Okola	50	SOCOOPO
	SA'A	50	SOCOOPSA
	Nanga-Eboko	50	SOCOODER
	Akonolinga	100	SOCOODER
	Eseka	50	SOCOODER
	Mbalmayo	50	SOCOODER
	Mbankomo	50	MIDEVIV
	Mfou	100	SODECAO
	Ngoumou	200	SODECAO
	Mbalmayo	100	SODECAO
East	Bertoua	2,600	DIRAGRI
	Bertoua	-	Zapi-East
	Abong-Mbang	-	SOCOOPED
	Bertoua	-	SOCOOPED
	Batouri	-	SOCOOPED
Extreme North	Maroua	1,000	DIRAGRI
	Kousseri	700	SEMRY Project
	Mega	700	SEMRY Project
	Yagoua	750	SEMRY Project
Littoral	Bonaberi	40,000	SOCAME
North	N.E.B.	1,000	MISSAMBE
	Garoua	1,000	DIRAGRI
	N.E.B.	200	SODECOTON
North West[a]	Kwen	1,800	N.W.A.
	Santa	1,800	N.W.A.
	Unions (11)	3,850	N.W.A.
West[b]	Bafoussam	10,000	CAPLAME
	Dschang	22,000	CAPLAME
	Mbouda	18,000	CAPLABAME
	Foumban	18,000	CAPLANOUN
	Bangangte	-	CAPANDE
	Bafang	4,000	CAPLAHN
South	Ebolowa	700	E.T.A.
South West	Kumba	3,000[c]	South West COOP

a. Additional 5,600-mt capacity is under construction.
b. Additional storage capacity of 7,800 mt is under construction.
c. Under construction.

Source: Ministry of Agriculture records.

The South West Province does not have enough fertilizer warehouse storage space to meet needs under the present distribution system. At present fertilizers are left in Douala for long periods of time because of the warehouses shortage.

In the North West Province, a program of warehouse construction is being executed. Presently 25 warehouses of a planned 62 having an 1,800-mt capacity each have been established at farm service centers. Road access to all of the warehouses has not yet been established. These would be used to provide temporary storage sites for stock of fertilizers at points of sale.

Currently, warehouses are being constructed using designs associated with the storage of crop produce. An open space is left under the eaves for ventilation. A fertilizer warehouse should be constructed so that it can be completely closed at night or during periods of high relative humidity.

In the Extreme North and North Provinces, fertilizers are often stored in the open during periods of low rainfall. This is a perfectly acceptable practice provided the stack is completely covered with a material that will not allow sunlight to pass through. At the railhead in Ngaoundere, SOGETRANS and SODECOTON use cotton warehouses for the temporary storage of fertilizers. A major problem is the lack of a suitable fertilizer warehouse. At present six warehouses having a 1,000-mt capacity each are under construction in these provinces.

The current fertilizer warehousing system has not been stocked on the basis of a central inventory management plan to meet demand by time frames. It has also not been stored as near the marketplaces as it should have been. Oversupply in one area and undersupply in others help to create artificial shortages at the farmer level. Farmers may use or be forced to use the wrong product as well and lose an opportunity for profit from fertilizer use.

Handling of Product--Throughout the fertilizer distribution system, both loading and unloading are done manually. Even in large warehouses, pallets were not generally in use.

Platforms or truck-bed-high loading docks to receive and to dispatch fertilizers in 30-mt truck lots were not observed. At most warehouses, the fertilizers were not placed on dunnage. Mechanical devices, e.g., conveyors or fork-lifts, were not used. Fertilizers were usually handled in truckload lots of a single grade.

There appeared to be two distinct philosophies in the present distribution system. The supply side endeavors to acquire fertilizers at the lowest tender price per ton regardless of quality. The other side presents a marketing position of trying to have enough supply on hand to satisfy the farmers' requests for fertilizers. Both tend to drive up inventories. An inadequate supply not only costs the loss of a sale but in the broader sense prevents the farmer-customer from making a profit from his purchase. In this case the farmer, the distribution system, and the country lose.

Transportation Modes Used--Transportation modes used are primarily trucks and railway. Each is important in the fertilizer distribution system.

1. Road Transport Fleet--For primary movement about 80% of the fertilizers are transported from warehouses in the vicinity of the port of Douala to storage facilities in the provinces by trucks. These vehicles vary from 8 to 40 mt in payload capacity. MORY, a large transfer firm, finds that the haulage rates and the availability of trucks vary substantially. For example, during the period when food is being transported to Chad the availability of transport is so restricted that the cost of transporting fertilizer is increased.

MORY, itself, owns 70 trucks and estimates that with these trucks they can deliver 5,000 mt/month to the western part of the country. They would invest in additional vehicles to ensure timely delivery if they were granted a 3-year haulage contract.

If only the road transport costs are considered, it is of course cheaper to transport fertilizer in the largest possible loads of 30-40 mt. But if associated costs to the national economy in terms of rebuilding damaged roads are included, there is no doubt that the loads should be restricted. Resolution of the problem of vehicle overloading is a national issue. The condition of the road network is discussed under infrastructure and additional government policies below.

2. Railway Transport System--The National Railway System of Cameroon operates a 1-m gauge railway with a route length in the west of 162 km and a line of 930 km to the north. Figure II-5 shows the extent of the railroad system. In 1962, a branch line was extended from Loum to Kumba, a distance of 35 km. The steep climb on this route prevents its use for heavy loads. The route from Douala to Nkongsamba (67 km) needs renovation. The route from Douala

to Ngaoundere (930 km) is fully operable. Two freight trains per day are dispatched north from Douala. Each can pull 900 mt from Douala to Yaounde and from there north each train can pull 1,200 mt. On the northern route, the track is in good condition, well maintained, and is not a constraint on the operation of the trains.

The trains travel from Douala to reach Yaounde the next morning, and they can reach Ngaoundere 2.5 days after leaving Douala.

Signaling is by telephone, telex, and local radio. Locomotives are adequate for the service indicated above and for shunting in the yards.

Several types of wagons are available for the transport of fertilizer:

1. Type A--97 m^3 covered (box), two door, capacity 40 mt.
2. Type B--Half-covered with sidewalls, 1.4 m high. These can be covered with tarps, capacity 30-40 mt.
3. Type C--Regular covered wagons with two doors, capacity 30 and 40 mt.

In addition, special wagons are available for transport of bulk cement, petroleum products, containers, heavy equipment, and platforms for logs.

No requirement for the movement of bulk fertilizers was identified in the present study. The consultants consider that sufficient wagons are available to meet the needs in the North and Extreme North Provinces for bagged fertilizer. Additional movement of food to Chad may impose a need to purchase additional locomotives and wagons should fertilizer use expand and the food for Chad become a continuing program.

The rail tariffs are fixed from Douala to specific railway terminals. These are:

	FCFA/mt[a]
Douala--Yaounde	FCFA 8.350
Douala--Eseka	FCFA 5.000
Douala--Belabo	FCFA 15.495
Douala--Ngaoundere	FCFA 22.995
Douala--Kumba	FCFA 3.730
Douala--Edea	FCFA 3.500

a. Add FCFA 499/mt if loaded in port.

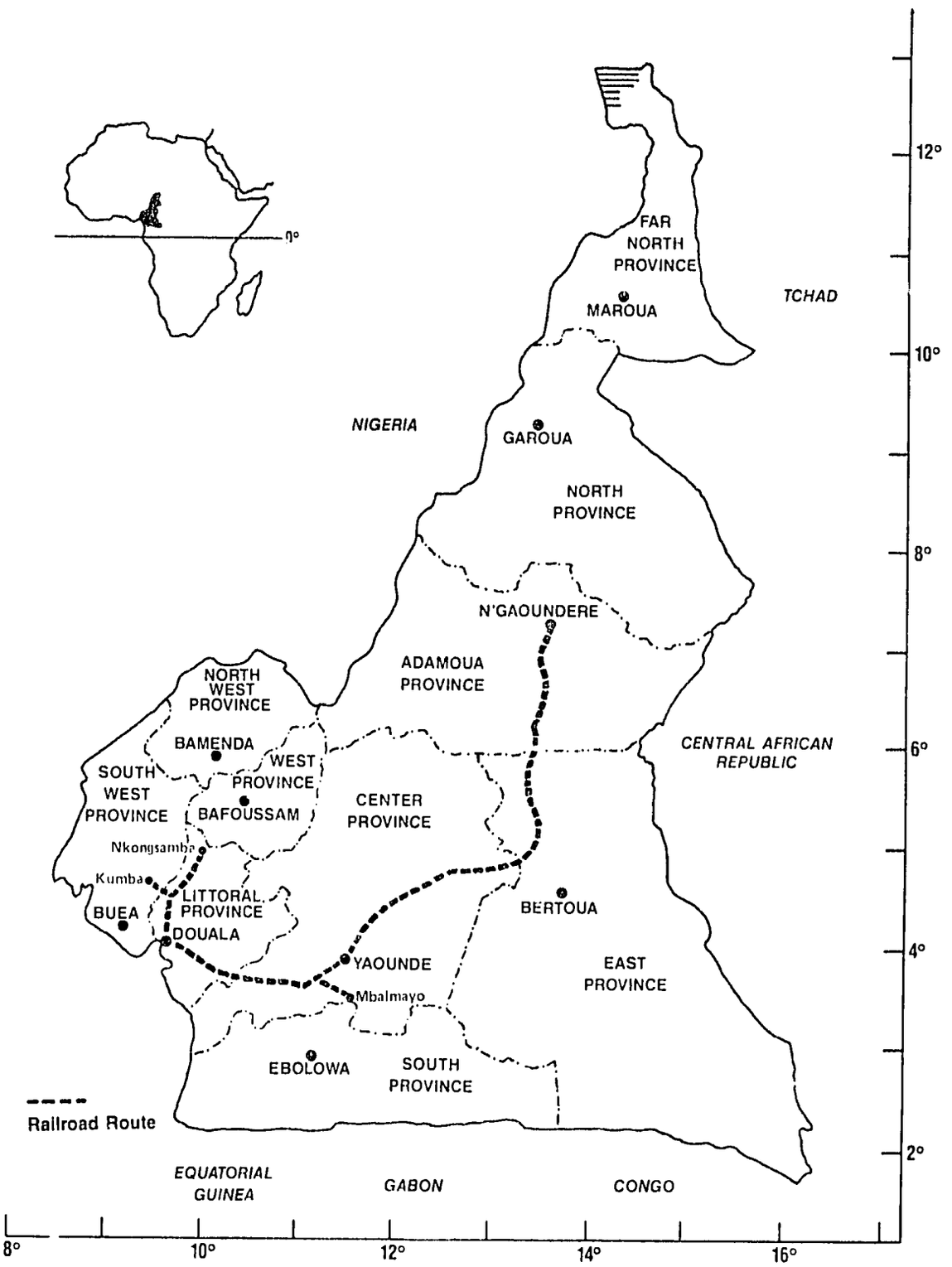


Figure II-5. Railroad Routes in Cameroon.

Other rail transport conditions relate to wagon holding time. The railroad will put wagons in position 1 day for loading without charge. If they are kept for the second and third day a charge of FCFA 41,180/day/wagon will be made. If kept for the fourth and fifth day the charge per wagon increases to FCFA 62,000/day.

Rail operations and rules must be followed in fertilizer shipments. Shipments are by individual wagon with loading and unloading incumbent upon the consignee. Conditions for the protection of the consignment are the responsibility of the railroad. Goods must be properly packaged, and in the case of fertilizer, the wagon must be lined with a protective material. Packages are required to be labeled, and every package in the shipment must have the name and address of the sender and the station of the receiver. This practice is not always followed.

Upon departure, a Notice of Arrival is sent to the consignee who is allowed one full day free for unloading. The recipient has the obligation to receive the merchandise that is shipped to him.

Wagons can be obtained on contract by stating the number of wagons required, type of merchandise to be hauled, dates of planned loading, and the destination. In the loading of wagons, three essential conditions must be observed:

1. The maximum load cited on the wagon must be respected.
2. The merchandise to be transported must be protected.
3. Other rail traffic must not be endangered.

The shipper is liable for overloading the railwagons and is subject to a threefold tax on the value of all packages in any overloaded consignment.

Transshipment of fertilizers at Ngaoundere involves offloading into either ordering agencies' trucks or into transshipment storage. There are sufficient trucks to transship 1,500 metric tons per day (mtpd). SOGETRANS tranships from the rail terminal to the following warehouse locations in the times indicated:

Origin	Warehouse Site	Required Time (days)
Ngaoundere	Garoua	1.0
Ngaoundere	Maroua	1.5
Ngaoundere	Yagoua	2.0
Ngaoundere	Kousseri	2.5

Studies by the Ministry of Transport indicate that improvements are planned for the rail network. The plans point to renovation of the route from Douala to Loum and extension of the network to Dschang. This would be accomplished if the bauxite deposit there is developed. Other plans indicate the need for establishing a route from Edea to Kribi and from Kribi to Sangmelina. When these routes are completed, fertilizer shipments will also be benefitted.

Review of Fertilizer Costs

IFDC consultants determined the marketing costs and compared their data with that obtained by USAID (1985). Fertilizer cost by products and importers for 1984/85 are shown in Table II-5.

During 1984 and early 1985 urea prices f.o.b. Western Europe ranged between US $118 and $165/mt. At a rate of FCFA 400 per US $1, these values become FCFA 47,111 and FCFA 66,000, respectively. The urea appears to have been purchased near the upper end of the annual price cycle. Urea prices have been in a general decline since 1981. For example, the f.o.b. world prices in August 1985 were at US $96 or FCFA 38,400/mt. Even by allocating US $100/mt or FCFA 40,000, a c.i.f. Douala price for 1985 urea purchases should be around FCFA 78,400/mt. The consultants found that 1985 tender urea prices c.i.f. Douala were FCFA 90,000/mt. The difference of FCFA 11,600/mt on a 5,000-mt lot amounts to FCFA 58 million. Closer monitoring of world prices at time of tendering, with the capability of purchasing from truly competitive sources, is required if fertilizer prices are to be kept to a minimum.

Fertilizer costs in the present distribution system for the services performed are high. A typical fertilizer cost per ton is estimated to be FCFA 191,168 at the retailer. (The major components accounting for that cost are shown later in this section in Table II-9).

Table II-5. Cost of Fertilizer c.i.f. Douala Port by Products and by Importers for Years 1984/85

Product	Price (FCFA/mt)	Importer	Amount (mt)
10-10-20	89,000	GAMMA 7	500
	110,310	SEPCAE	500
22-10-15 + 5S + 1B	126,488	SEPCAE	1,000
15-20-15 + 6S + 1B	133,518	SEPCAE	6,000
22-10-15 + 5S + 1B	115,200	SEPCAE	7,000
20-10-10	98,989	ATICIA	12,000
	105,500	SUPERFOS	8,000
12-6-20	114,000	SEPCAE	5,000
	114,000	WANDA	10,000
18-46-0	140,180	SEPCAE	1,650
	114,000	C.F.C.	400
		GAMMA 7	400
21-0-0	69,500	C.F.C.	300
	69,216	SEPCAE	13,500
	70,175	DIANA SICAC	7,000
46-0-0	112,000	WANDA	4,680
	117,500	PELLENGET	8,000
	76,000	SEPCAE	8,850
0-0-60	76,000	GAMMA 7	1,250
	86,250	SEPCAE	6,500
Phosphate rock	56,751	SEPCAE	2,000
Kieserite	70,300	SEPCAE	750
0-46-0	109,500	SEPCAE	100
0-0-50	139,000	SEPCAE	200
0-20-0	79,250	SEPCAE	450
TOTAL			106,030[a]

a. Of the total 106,030 mt imported during 1984/85, SEPCAE imported approximately 50%.

Source: SEPCAE records.

Port Costs

The cost of clearing the fertilizers at the port is paid by the importer. Some of the charges relate to the value of the shipment, and others are assessed on a unit basis. Still others are negotiated on an individual job basis. According to the information provided by MORY, a port clearing firm, the following charges are made for representative products based upon 1984/85 import costs.

	Ammonium Sulfate (21-0-0)	Urea (46-0-0)	Compounds (20-10-10)	Compounds (12-6-20)
	(FCFA/mt)			
Maritime insurance (2.5%)	1,740	2,454	2,510	2,850
Credit opening fee	1,399	1,963	2,008	2,280
CNCC fee	287	402	411	467
Stevedoring	2,000	2,000	2,000	2,000
Transit handling and loading	2,039	2,039	2,039	2,039
Covering on quay	612	612	612	612
Registry rights	1,399	1,963	2,008	2,280
Losses to importer dock	700	982	100	114
Importer's margin (estimated 3%)	2,100	2,944	3,012	3,420
Total port costs	10,476	15,366	14,692	16,062
Fertilizer cost at importer warehouse dock	80,476	113,532	115,085	130,062

Source: Importer, stevedoring, and transfer firm records.

Warehousing Costs

Adequate fertilizer storage capacity does not exist at many of the retail outlets. Much of what exists is used for storage space of export crops, as well as for fertilizer. The apparent need for increased warehouse capacity is dictated by the fact that the allocated fertilizers are received 9 months to a year before the time the farmers buy them. Stocks purchased for the Ministry of Agriculture tend to remain in storage at the Bonaberi shed until the ordering agency chooses to pick them up for haulage back to their facilities in the province. This procedure adds to the overall cost because it costs more to store in Douala than in the provinces; in addition, this procedure often limits timely availability.

The inventory holding costs in the field warehousing network are not identified separately from other retail expenses. In the absence of commercial warehousing for fertilizers, there are no cost guidelines for provision or operation of fertilizer warehouses per se. Based upon observations of Cameroon and similar fertilizer situations, the consultants made the following cost estimates for warehousing fertilizers on a system-wide basis:

1. Interest on 106,030 mt valued at FCFA 100,000/mt for 9 months at 13% would be FCFA 1.034 billion or FCFA 9,750/mt.
2. Storage facilities--Construction of new facilities costs about FCFA 60,000/m^2. A 1,000-mt warehouse constructed new will cost FCFA 29,165,000. Interest on the undepreciated value would be equal to FCFA 3,791,450 or FCFA 3,792/mt/year.
3. Handling costs were calculated on the basis of two liftings--one at the primary distribution center and one at a secondary storage site. These are FCFA 30/bag to off-load and FCFA 30/bag to load. This amounts to FCFA 1,200/mt or FCFA 127,236,000 for the 1984/85 season.
4. A study made by FONADER in February 1985 of the current stockage system revealed a secondary transportation cost of FCFA 4,000/mt. The components of these costs were not further identified. The consultants chose to use this figure of FCFA 4,000/mt.
5. Depreciation, if based upon new facilities, would be about FCFA 2,000/mt/year. However, fertilizers are frequently stored in facilities that were originally constructed for other purposes, e.g., coffee storage. The cost of depreciation chargeable to fertilizers would be about FCFA 1,000/mt.
6. The consultants were not able to ascertain any organization that carried insurance on fertilizer stocks positioned in field warehousing. However, importers do carry insurance on their stocks located in their warehouses in Douala port. No charge was included for this insurance.
7. Management of the storage facilities--e.g., construction, security, bookkeeping, labor supervision office upkeep, etc.--is calculated at FCFA 125/mt or FCFA 13,253,750 for the system in 1984/85.

The total warehousing costs (inventory management) for the entire system (106,030 mt) are estimated to be FCFA 19,866/mt/year.

Transport Costs

For the purpose of evaluating and comparing transport costs, the consultants consider that it would be inappropriate to adopt the conventional vehicle operating cost relationships such as are used in benefit/cost studies. Fertilizer transportation in Cameroon is essentially a commercial operation, in which each hauler has his own perception of profit and risk. Any assessment should be based on commercial rates.

It is considered that a more rational and satisfactory cost would be obtained if the road haulage rates were based on the distances to individual warehouses rather than on the gross measure to the headquarters of the ordering organization. The records do not reveal as many specific receiving or primary distribution centers as are probably in use. At the same time the true rates are seasonal and are based upon demand in the port of Douala at any one time. Therefore, the official rate of FCFA 31.05/ton-km is usually exceeded. Estimates by transporters indicate that on the longer routes practical rates are two and one-half (2½) times the official rate.

Because of the wide variability in practical haulage rates, e.g., customer truck, backhauling, seasonal demand, etc., the calculations for the purpose of this study are based upon the official costs and rates authorized by the Ministry of Transportation. If desired these costs can be escalated to current rates by the use of an appropriate coefficient.

A study of vehicle operational costs in Cameroon was made in January 1985 by the Highways Department of the Ministry of Equipment. It revealed a cost of FCFA 509.95/km for the operation of an articulated 28-mt truck operating for 50,000 km/year on a good tarred surface road. Because many destinations are not located on such a road, a more appropriate operational cost figure for this type vehicle would be FCFA 642.16/km or FCFA 22.93/ton-km. These costs are well below the authorized rate of FCFA 31.05/ton-km, which the consultants have elected to use. These rates are multiplied by the kilometers to each identified warehouse, and this value is multiplied by the total tonnage transported to the warehouse to establish an average weighted transportation cost per ton. The estimated weighted transportation costs in 1984/85 to all destinations is FCFA 799,960,000 or about FCFA 9,700/mt.

The transport costs from Douala port to specific warehouses were calculated in direct proportion to the distance. It is recognized that rates/ton-km for the longer distances may be somewhat less than those cited (Table II-6). Special official rates to selected destinations differ slightly from those computed on a distance-only basis (Table II-7). The combination of rail and road rates used to serve the Extreme North and North Provinces show values ranging from FCFA 34,000 to FCFA 52,000/mt (Table II-8).

Fertilizer Losses

No measure was made of the losses sustained by those agencies handling nonsubsidized fertilizer. It was reported that they are less than 2%. In the subsidized sector various claims have been made that suggest high levels of loss in the fertilizer distribution system. However, no correlation of receipts against dispatches is available system-wide, and thus rigid conclusions cannot be made. Any figures used for levels of physical loss are then judgement decisions. Studies elsewhere have indicated that at each transfer there is a 1% loss. At this rate and with an average of five transfers, the losses could be as much as 5% of the total tonnage. If we assume that a ton of fertilizer at the port costs FCFA 100,000, then these physical losses in 1984/85 would amount to FCFA 538 million or FCFA 5,000/mt. Repackaging of fertilizers at the Bonaberi shed serves to reduce these losses. Losses sustained near the point of consumption are more costly than those at the port where most of the losses probably occur. To gain accurate data, the first essential is to install a system of accurate control and reporting of all movements of the fertilizers. Secondly, a complete inventory of all stocks to which the Ministry of Agriculture has title needs to be made.

Serious losses of various types have been seen in the field, but confusion arises for two reasons:

1. There is no clear understanding or definition of what is meant by "loss."
2. There is too much concentration on historical problems.

True physical loss of fertilizer through the distribution system, e.g., due to spillage from damaged bags, theft, or spoilage in storage, appeared to be about normal for the system again in 1985. In theory, loaded trucks moved directly from importers' warehouses to the primary distribution centers with no intermediate handling. In practice, there are reports of large losses in the unloading at the port and of missing fertilizer during transport and storage.

Table II-6. Road Transport Costs Using Authorized Rates 1985

Province	Warehouse Location	Distance (km)	Freight (FCFA/mt)	Estimated Amount (mt)	Total Freight (millions FCFA)
Extreme North	Maroua	1,399	43,438	866	37.62
	Kousseri	1,679	52,133		
	Yagoua	1,509	46,854	2,038	95.5
	Mokolo	1,479	45,923	1,419	65.2
	Mora	1,459	45,302	561	25.4
	Kaele	1,459	45,302	1,370	68.8
	Guider	1,303	39,155	1,757	
North	Ngaoundere	890	27,635	-	
North West	Kwen	352	10,930	3,135	33.68
	Santa	326	10,122	3,135	33.68
	Bamenda	346	10,743	3,135	33.68
	Wada-Wum	411	12,762	195	2.5
	Unvda-Ndop	388	12,041	19	0.25
West	Bafoussam	266	8,259	20,296	202.96
	Dschang	326	10,122	20,296	202.96
	Mbouda	296	9,191	20,296	202.96
	Foumban	388	12,047	20,296	202.96
	Bangangte	246	7,638	20,296	202.96
South West	Kumba	126	3,912	2,918	11.4
	Cdc	79	2,453	7,000	1.22
	Palmol	181	5,620	1,696	9.53
Littoral	Bonaberi	0	0	5,742	
	Loum	99	3,074	16,668	61.6
	Nlohe	104	-	16,668	61.6
	Manjo	119	3,229	16,668	61.6
	Nkongsamba	143	3,695	16,668	61.6
	Melong	169	5,247	16,668	61.6
	Kribi	209	6,489	5,275	34.2
	Anacam	75	2,329	82	0.2
	SOCAPALM-Dibombari	44	1,366	4,650	6.3
South	Ebolowa	345	10,712	569	6.1
	Yaounde	267	8,290	7,529	62.4
	Ombessa	360	11,178	7,529	62.4
East	Bertoua	623	19,344	0	-
	Abong-Mbang	506	15,711	720	11.3
	Batouri	713	22,139	0	-
	Nboteng Belabo	391		2,970	1.2

Source: Ministry of Transport.

Table II-7. Special Road Haulage Rates to Selected Locations in 1984

Location	Distance From Douala (km)	Official Rate (FCFA/mt)
Ngaoundere	890	27,635
Bamenda	346	10,743
Bafoussam	266	8,259
Dschang	326	10,122
Foumban	388	12,047
Bafang	200	6,210
Limbe	69	2,142
Lobe	205	86,365
Yaounde	273	8,477
Ebolowa	345	10,712
Abong-Mbang	506	15,711

Source: Ministry of Transport.

II-8. Combination of Rail and Road Rates for Fertilizer Delivery to North and Extreme North Provinces at Approved Road Rates

Location	Rail Rate to Ngaoundere	Road Rate to Destination	Transfer Rate	Total Rate
	(FCFA/mt)			
Garoua	22,995	8,100	3,300	34,395
Maroua	22,995	17,300	3,300	43,595
Yagoua	22,995	20,016	3,300	46,311
Kousseri	22,995	26,480	3,300	52,775

Source: Consultants' estimates.

Material is picked up months or even years late from the Bonaberi shed where it may have gone out of condition. Another main type of "loss" is accounting or administrative loss. Simply stated, this means that less than actual tonnages are officially recorded as being received with the difference being given away or sold. Until a rigorous system of control is introduced and enforced by management, losses cannot be either measured or controlled.

Still another type of "loss" relates to those well-meaning retail managers who sell fertilizer to high-risk buyers. In a study by a special mission from FONADER, it was found that the handling of 11,865 mt of fertilizer in one case accrued a risk of nonpayment loss of FCFA 31,323,600, or FCFA 2,640/mt handled. In another case where 5,356 mt was distributed, these losses were FCFA 14,139,840 or the same FCFA 2,640/mt. It was determined that 50% of the fertilizer sold on credit was lost due to nonpayment. The risk of handling funds would be an additional 12% of sales value. This study also estimated that "diverse costs," which were undefined, accrued to the extent of 10% of sales value of the fertilizer. These losses are substantial and amount to FCFA 16,553/mt or a total of FCFA 1.06 billion in 1985 for subsidized fertilizers (Table II-9).

At the time of this study it was reported by FONADER that SEMRY owed in excess of FCFA 1 billion for fertilizers.

Operational Costs

To determine operational cost for subsidized fertilizers in the current system, 20-10-10 was selected and used to represent a typical grade. The data to make the calculation are based on the above costs as shown in Table II-9.

1. For the subsidized fertilizer sector, overhead was calculated on the basis of the following assumptions:
   a. That two hundred employees are engaged in fertilizer functions as a part of the national-level staff.
   b. That the employees allocate 50% of their time to fertilizer functions.
   c. That the expenses of employee operational cost are 50% of base salary, i.e., office, vehicles, travel, etc.
   d. That an average base salary for employees including benefits is FCFA 450,000.

   This overhead for subsidized fertilizer is calculated to be FCFA 1,189/mt.

Table II-9. Typical Fertilizer Cost Per Ton by Items in 1985

Item		FCFA/mt
Product cost (c.i.f. Douala)		100,000
Port handling		14,692
Warehousing		
Interest	9,750	
Facility	3,792	
Handling	1,200	
Transport	4,000	
Depreciation	1,000	
Insurance	-	
Management	125	
Subtotal		19,867
Transport		9,700
Losses		
Physical (5%)	5,000	
Nonpayment (2.6%)	2,640	
Risk money (12%)	16,917	
Subtotal		24,557
Diverse (10%)		16,553
Distribution margins		4,000
Administration		610
Overhead		1,189
TOTAL		191,168

Source: Consultants' estimates.

The total cost per ton of a typical fertilizer is estimated to be FCFA 191,168. The total operational capital requirement in 1984/85 for the 64,332 mt of subsidized fertilizer, based on turning the capital once per year, amounted to FCFA 12.2 billion. Only the interest on inventory, based on c. & f. Douala prices, has been included. Working capital on other cost items, such as accounts receivable, staff, etc., has not been included. Interest on other marketing capital is not considered in these estimates.

2. To calculate the capital requirements for the nonsubsidized sector the following assumptions are made:
   a. Losses are estimated at 2% of the tons handled.
   b. Costs are based on delivered basis at distribution centers.
   c. Distributor margins are not applied.
   d. Transport is included in costs even though the fertilizers are moved most frequently as a backhaul in vehicles owned or operated by the parastatal. This is considered to be a lower cost than the published official rates.
   e. Administration costs are assumed to be FCFA 2,000/mt.
   f. Overhead costs are assumed to be FCFA 600/mt.

   The capital requirement for the nonsubsidized sector becomes FCFA 146,400/mt. This is approximately the same amount as determined by SODECOTON based upon the delivered cost of urea at Goura. The total capital needed in 1984/85 for 40,724 mt of nonsubsidized fertilizer amounted to FCFA 6.0 billion. The total operational capital for both fertilizer channels is estimated to be FCFA 18.2 billion annually. A large part of the operational capital requirements could be cut in half by turning the inventory twice per year instead of once and having tighter management control of losses.

Direct Retailing Cost of Subsidized Fertilizers

Retailing costs are difficult to determine because fertilizer sales are made by organizations that also carry out many other activities. Separate accounting costs for fertilizers are seldom made. For example, SEMRY has operations geared to production of rice and not to retailing fertilizers. SEMRY includes the cost of subsidized fertilizers in a package of inputs that cost FCFA 156,000/ha in 1985. This covered cost for water, fertilizer, service, and

insecticides. A similar situation exists for SODECOTON and the sale of nonsubsidized fertilizers to cotton farmers. UCCAO and a select few of the cooperatives have more clearly defined a fertilizer retail operation although even here their operations relate to the purchasing of coffee.

Retail cost calculations are based upon the following assumptions:

1. Total delivered costs are prorated between retail and nonretail functions.
2. The identified retail costs are not necessarily those paid by the retailer in the present system.
3. Approximately two-thirds of the total warehouse cost is assigned to the retail function.
4. Of the total cost of fertilizer in the current system, 15.6% is assumed to be loss. Such losses include physical, nonpayment, and risk for handling monies.
5. One-half of the administrative cost is prorated to the retail level.

The major retail distribution costs are estimated to be FCFA 34,031/mt or 18% of the total cost of distribution (Table II-10). From another position, losses of various types amount to 65% of the identified retail costs.

In the case of nonsubsidized fertilizers, some of the ordering agencies, primarily SODECOTON, sell fertilizers to farmers at their retail facilities. They in turn purchase the farmers' crop produce utilizing these same facilities. The actual retail costs of fertilizers are included in a total cost for other inputs and services that are provided to farmer customers.

Other Costs

There are other costs that result from the current fertilizer system. For example, making fertilizers available to farmers after the correct application period has passed denies the farmer the opportunity to produce good yields and prevents the profit potential inherent in his fertilizer purchase. This is a loss or cost to farmers and to the national economy. This cost may be 2-3 times greater than the direct losses identified in the present distribution system.

Another indirect cost suffered by the national economy is the repair of road damage created by overloading trucks with fertilizers.

Table II-10. Estimated Direct Retail Cost of Subsidized Fertilizers in the Current 1984/85 System

Item	Cost FCFA/mt
Secondary transportation	4,000
Warehousing	11,058
Promotion	675
Losses	21,993
Administration	305
TOTAL	34,031

Source: Consultants' estimates.

There is also a cost to the national economy because scarce resources must be allocated from the government's budget to support the present fertilizer system.

Estimation of the Costs of Fertilizers by Product and by Nutrient

The costs cited in "Review of Fertilizer Costs" above were based upon a product with a c.i.f. Douala cost of FCFA 100,000/mt in 1984/85. Comparable costs for other products are cited in Table II-11. The port and retail costs are calculated in part as a percentage of the c.i.f. value. The physical distribution cost is constant for all fertilizer products.

It is interesting to compare these purchase prices with current world market prices (Table II-12). For the most part the purchase prices are competitive with world market prices. The purchase price of ammonium sulfate and urea is slightly below the quoted world market price. The price of compound fertilizer 20-10-10 was exactly on the world market price. The other products purchased were slightly above the world market prices.

The delivered cost of nutrients at the retailer was calculated on the c.i.f. Douala cost of single-nutrient products, i.e., 46-0-0 and 0-0-60. The cost of phosphate was based upon the value of P_2O_5 in 18-46-0 (Table II-13).

If nitrogen only is considered, ammonium sulfate (21-0-0) is an expensive source of nitrogen when compared with urea (46-0-0) (FCFA 725/kg of N versus FCFA 401/kg of N). If the cost of K_2O in potash (0-0-60) and the cost of P_2O_5 in 18-46-0 are used as a basis of calculation, then the cost of nitrogen in such compounds as 12-6-20 is 60% higher than the nitrogen in urea (46-0-0). Also the P_2O_5 cost in such low analyses as 12-6-20 is more expensive on a nutrient basis than the P_2O_5 in high-analysis products such as 18-46-0.

The Current Extension Service

One of the major constraints on fertilizer use in Cameroon is the lack of educational programs on crop production techniques including those related to fertilizer use on all crops and especially on food crops. The extension service should not spend time in allocating inputs but on more and better educational activities designed to teach the farmer the latest techniques for increasing yields and decreasing cost of production.

Table II-11. Cost of Fertilizer Products at Different Points in the Distribution Chain in 1985

Product	c.i.f. Cost	Port Costs	Retail and Delivery Costs	Total Delivered Cost
	('000 FCFA/mt)			
21-0-0	70	11.9	70.4	152.3
46-0-0	98.2	14.1	72.6	184.9
12-6-20	114	15.8	74.5	204.3
20-10-10	100	14.6	75.9	190.5
22-10-15 + 4S +1B	115	15.9	76.3	207.2
0-0-60	81	12.9	69.0	162.2
18-46-0	131.6	17.3	80.6	229.5

Source: SEPCAE data, Consultants' estimates.

Table II-12. Comparison of Current World Prices of Fertilizers With Prices Paid in 1984/85[a]

Product	Purchase Price	World Market Delivered Price
	('000 FCFA/mt)	
21-0-0	70	72
46-0-0	98.2	100
20-10-10	100	100
12-6-20	114	108
22-10-15 + 4S + 1B	115	112
0-0-60	81	80
18-46-0	131.6	120

a. FCFA 400 = US $1; c.i.f. Douala; ocean freight estimated at FCFA 400,000/mt from U.S. Gulf or European ports in all 5,000-mt lots. All products bagged.

Source: SEPCAE Records, and Green Markets, October 1985.

Table II-13. Nutrient Cost in Different Fertilizer Products at the Farm Gate in 1985

Product	N	P_2O_5	K_2O
	(FCFA/kg of nutrient)		
21-0-0	725	-	-
46-0-0	401	-	-
0-0-60	-	-	271
18-46-0	401	341	-
12-6-20[a]	401	341	271
12-6-20[b]	1,078	341	271
20-10-10[a]	401	341	271
20-10-10[b]	645	341	271

a. Based on cost of nutrients in single-nutrient fertilizers.
b. Based on cost of K_2O in 0-0-60 and P_2O_5 in 18-46-0 only.

Source: SEPCAE records, British Sulphur reports, Green Markets, October 25, 1985.

The number of farm families per extension agent is often cited as a measure of the potential effectiveness of an extension service. In Cameroon the average number of families served by each extension worker, according to Kelso and Gagne-Gervais (1983), varies by province and ranges from a high of 1,679 in the North, Extreme North, and Adamaoua Provinces to a low of 139 in Littoral, 143 in Central and South, 191 in East, 266 in West, 592 in South West, and 616 the North West Provinces.

The national extension service appears to be very narrow in its educational programs. Some parastatals have good extension programs on specific crops, i.e., SODECOTON on cotton, cooperatives on coffee, etc. The national extension service has worked with the parastatals and plantations on cultivation practices. For the most part, parastatal staff seemed to feel they were ahead of the extension service staff on current practices. Parastatals are in the process of starting up educational activites on associated food crops. The Agricultural Census shows that the cocoa crop accounts for only approximately one-fourth of the farmers' total income. The extension service is serving this segment of agriculture more than the food crop sector. The extension service can increase the farmers' income by teaching modern methods for the production of all food crops. There seems to be a prevailing idea that farmers can produce traditional food crops without new technology.

The study team found very little evidence of educational programs at the farmer level carried out by private input suppliers. The extension service did not appear to be working with the private sector on the transfer of technology. This sector is a large untapped source of technology and an established avenue for the transfer of information to farmers.

The study team found that SEMRY, SODEBLE, and others had formal extension activities in the past, but these programs have stopped for various reasons. Their extension activities appear to be confined to their project farmers with very little information escaping to nonproject farmers. The MIDENO Project in the North West Province, the Wum Development Authority, the Upper Nun Valley Development Authority, and to some degree UCCAO in West Province have educational programs that benefit the general farming community through actual crop production programs. Each of the IRA stations has a program for training.

General crop production bulletins, leaflets, etc., containing specific recommendations for fertilizer use were not generally evident at the farmer and fertilizer retailer level. In the past leaflets have been available from time to time. One leaflet on tools for use in planting was available (Appendix E).

At the time of this study, fertilizer recommendations for crops cultivated by farmers in each ecological zone were under preparation by IRA. This information is badly needed and should greatly benefit the fertilizer use programs. Additional research is needed, however, so that more appropriate fertilizers can be matched with soil and crop requirements.

There is a need to provide government extension personnel with regular training and necessary information. Some retraining is being undertaken. SODECOTON schedules a meeting at least once per year to update their agents. MIDENO at Bamenda has a program for familiarizing agents with the latest crop production techniques and input recommendations based on Cameroon research data.

The study team failed to find evidence of extensive use by extension agents of radio programs, farmer meetings, poster materials, billboards, field plot signs, point of purchase identification, and other media normally accepted as extension educational tools.

Personnel Requirements to Manage the Present Fertilizer System

To adequately evaluate personnel who are involved in the current fertilizer distribution system, a study of individual performance against specific job descriptions or at least against job assignments would have to be made. Job descriptions, written or oral, were not generally found. In evaluating personnel assigned to the current system, the following functions were reviewed:

1. Management (administration).
2. Forecasting.
3. Ordering and purchasing.
4. Financial management.
5. Product planning.
6. Sales.
7. Promotion.
8. Documentation.
9. Market research.
10. Physical distribution including warehousing and transportation.
11. Pricing/economy of use.
12. Evaluation and control procedures.
13. Personnel development.
14. Soil fertility research.

Those management skills relating to in-depth planning, organizing, implementing, and evaluating had not been generally developed and put into operation. A need for more fertilizer technology is very evident.

In evaluating the fertilizer distribution personnel it should be pointed out that the system itself often made the personnel appear to be inefficient in job performance. Management appeared weak in many situations because responsibility and authority for performance were not delegated to the person designated to carry out specific functions. For example, a physical inventory of fertilizers by removing the bags, counting, and replacing them in nine warehouses is conducted twice per year at SEMRY. The cost of the inventory for labor alone is FCFA 24/bag. This does not include management time. This procedure was started years ago and continues even when it could be stopped by good management. Management appeared to be adequate in a few of the large parastatals where an efficient fertilizer distribution program exists.

Another area in which the subsidized channel makes performance of duties appear weak is the forecasting of demand. Because this occurs on a yearly basis, it creates problems in inventory management, transport, materials handling, warehousing, and crop production for those engaged in these downstream activities. The fertilizer tonnages that end up being imported are a function of funds allocated and not of the effective demand at the farm level. The ordering and purchasing of subsidized fertilizers are inefficient because of the complexity of system that is followed.

Performance of duties is weak as a result of either lack of knowledge or ineffective implementation. Training is needed in such areas as soil fertility and fertilizer research, administration, marketing, planning, organizing, directing, documentation, promotion/education, sales techniques, market research, economics of use, fertilizer technology, physical distribution, communications, and personnel development.

Generally, it can be stated that capable personnel to carry out fertilizer marketing functions are available in Cameroon but must be trained for specific functions if a low-cost fertilizer marketing system is to be implemented. This is especially true for general management, finance, production, marketing, economics, and agronomy. A management system to select, train, and motivate personnel for acceptable performance levels is urgently needed. Personnel selection should be made for specific jobs with job descriptions. The best possible person should be selected for each position. If personnel are not available for a specific position, e.g., commercial agronomist or economist,

individuals should be selected for these positions and then given formal and on-the-job training. They may be sent to a university or organization that can provide the specific training. A curriculum on fertilizer technology and input marketing that meets the needs in Cameroon should be established at the universities.

Constraints to Fertilizer Use and Recommendations to Overcome Them

The current fertilizer system is a prime contributor of constraints to fertilizer use in Cameroon. The constraints to fertilizer use can be categorized on the basis of national policy issues and technical problems.

1. National policy issues.
   a. Insufficient allocation of funds for the importation of subsidized fertilizer.

      Recommendation--Induce the creation of a self-supporting firm with adequate capital to purchase and market the fertilizer needed to meet the effective demand. Remove subsidy on fertilizers to free up funds.

   b. Subsidized fertilizers that are sold at a uniform price per bag or ton, rather than on the value of nutrients contained. This creates an economic waste by confusing the farmer on the selection of the appropriate products.

      Recommendation--Price each fertilizer grade according to its concentration of nutrients and teach the farmer to purchase on a nutrient basis.

   c. Use of relatively low analysis fertilizers, such as 21-0-0 (ammonium sulfate) and 12-6-20 (compound).

      Recommendation--Develop a crop production program that includes the newer, higher analysis fertilizers such as 10-30-10 and urea.

   d. Low benefit/cost ratios reduce farmer interest in commercial crop production.

      Recommendation--Ensure that the prices for crops maintain a favorable benefit/cost ratio. This commits the GOC to stimulate production of those crops to which it assigns a national priority or of those crops in which Cameroon has a comparative advantage.

e. The lack of a national fertilizer sector plan.
Recommendation--Improve policy coordination among ONCPB, FONADER, and the Office of the President or the Treasurer to foster the establishment and operation of a self-supporting fertilizer sector. Engage an experienced firm that has been successful in the development and implementation of a country-wide fertilizer marketing and production system to prepare a detailed plan.

f. Need for upgrading management skills, generally.
Recommendation--Employ experienced personnel to establish and operate a fertilizer system and to provide in-service training for the development of the national staff. Use formal course work to orient front line supervisors to their responsibilities.

g. Limited rail system and primary and feeder roads, which restrict the movement of fertilizers from port through market areas to farmers.
Recommendation--(a) Rail system--extend and improve the railroad facilities to Eschang to offer lower freight rates and to ensure sufficient capacity to deliver fertilizer to a high-consuming market and to haul crop produce to markets. (b) National roads--provide tar surface especially in the North West and South West Provinces and between Bafoussam and Ngaoundere to allow year-around traffic; (c) Provincial roads--extend these routes in the Central and West Provinces; (d) Departmental Roads (feeder)--substantially accelerate the allocation of funds for farm-to-market road construction especially in the heavily populated farming areas. This will particularly help to lower the cost of delivering and improving access of fertilizers to farmers and to assist with the movement of crop produce from farm to urban market. Planners should expect a haulage of 8-10 mt of farm produce for each ton of fertilizer sold for crop production.

2. Technical Constraints.

a. Draft in Douala port of 7.8 m, which is inadequate for utilizing vessels of most economic size.
Recommendation--Employ 5,000-mt vessels until harbor will easily accommodate larger vessels.

b. Port unloading equipment that results in excessive physical loss and damaged products.
Recommendation--Construct adequate unloading facilities for fertilizers that would include facilities for handling, storing, and bagging bulk fertilizer.

c. Lack of rapid and frequent communications to and from rural areas.
Recommendation--Extend and improve rural telephone, telex, and courier networks.

d. Inadequate dockside storage in Douala port where products are exposed to high-humidity conditions on a continuing basis.
Recommendation--Construct a warehouse in the port area specifically for fertilizer storage that is suitable for the weather conditions. Transship fertilizers as quickly as possible from the port area to the drier consuming areas.

e. Insufficient transportation capacity to accommodate rapid movement of fertilizers from the port area to primary distribution centers. This often leads to freight rates as high as 2½ times the approved rates.
Recommendation--Employ a minimum of two contract haulers of adequate capacity to transport fertilizers from the Douala port warehouses to market areas on a regular and continuing basis. This limits the wide fluctuations in demand for transport.

f. Unavailability of a supply of appropriate fertilizer at the retailer when needed.
Recommendation--Establish a continuing forecasting system and a centralized inventory management operation that can provide for a buildup of appropriate fertilizer stocks at each retail sales point in advance of sales during the cropping season. Provide for the maintenance of a safety stock and minimum stockage levels at all retail and other storage points to reduce stockouts to a reasonable level.

g. Lack of transfer of information on crop production practices at the farmer level.
Recommendations--(a) Establish educational programs, i.e., demonstrations, farmer meetings, literature and visual aids, as an integral part of the marketing system to educate farmers, especially those producing food crops; (b) train extension staff, retailers, and others on the use, marketing, and production of fertilizer products; (c) identify and support research on factors limiting crop yields.

h. Too few market outlets for fertilizer and marketplaces for crop produce that are convenient to the food-crop farmer.

Recommendation--Establish independent retail outlets in all major crop produce markets. Encourage fertilizer retailers to become buying agents for crop produce, including food crops.

i. Retailers who are not adequately trained in fertilizer technology and who do not advise farmers on proper fertilizer use.
Recommendation--Select retailers who will be capable of advising farmers on improved cropping practices. Provide the retailers with a continuing formal development program and with on-the-job training with frequent visits by salesmen and agronomic service personnel.

j. Inadequate fertilizer warehouse storage in the South West Province. Suitable warehouses for fertilizer storage are also not available in the best locations to serve retail and farmer customers in most provinces.
Recommendation--Make low-cost loans or grants available for warehouse construction. Construct closable warehouses of suitable size and employ proven fertilizer handling and storage techniques. Warehouse site selection should be based on the most efficient physical flow of fertilizers to the farmers.

k. Purchasing procedures that are so complex that they cause delays in arrivals of fertilizers at the farm level. This increases inventory expenses and denies farmers the profits from fertilizer use.
Recommendation--Establish a private company that has the authority and capability to purchase, process, and market the required fertilizers. Authorize the company to operate on a profit and loss basis with a minimum of government restrictions.

l. Call for Tenders that fails to adequately specify the product quality, packaging, labeling, inspection, procedures, laboratory analytical methods needed, delivery time, and conditions.
Recommendation--In tendering for fertilizers, follow the internationally accepted standards, such as those set forth in the USAID Small Business Memo dated September 7, 1982 (see Appendix H).

m. Need for more research, especially on farmer fields, to determine the fertilizer type, amount, and methods of application for optimum food-crop yields. At present, nutrients are not applied according to soil and crop requirements in most cases. This results in a waste of nutrients. Research should include all nutrients essential for crop production.

Recommendation--Establish an accelerated national food-crop production research program. The program should link researcher, extension workers, fertilizer marketing system, and farmers in determining site-specific solutions to crop production problems. The required equipment to perform evaluation of soil fertility research should be provided.

n. Use of 50-kg bags of subsidized fertilizers, which are broken down and repackaged into small bags for resale at prices above the official rates. Presumably this is to satisfy financial and transportation limitations of a class of customers.

Recommendation--Establish a test market to determine channels, products, and appropriate package size of fertilizers for the nonfarm and small holder markets.

o. Need for a wider selection of fertilizers to better meet the soil and crop production conditions.

Recommendation--Introduce high-phosphate fertilizer grades where possible and substitute urea for ammonium sulfate. Determine the need for and supply lime and other nutrients as research indicates. Establish a blending system to allow more production of fertilizer grades required for best crop production.

p. Possibility of limited crop response to fertilizers caused by the insufficient use of lime to supply calcium and magnesium and to reduce aluminum toxicity.

Recommendation--Develop an economical source of agricultural limestone and market through fertilizer channels.

q. Existence of areas where soils supply insufficient amounts of sulfur, boron, zinc, and perhaps other nutrients for economical crop yields.

Recommendation--Conduct research to define deficient areas and to determine crop response levels for each nutrient. Select appropriate supply sources and market through fertilizer channels.

r. For many farmers, limited purchasing power for essential inputs, whether they be fertilizers, improved seed, or plant protection chemicals. The small holders are more affected than the larger farming operations.

Recommendation--Establish an agricultural production credit bank and a plan for making loans available to farmers for the purchase of essential inputs. The loan program should be on a self-supporting basis.

Credit

The study team was informed by several distributors that the lack of purchasing power at the farm level was a major constraint to fertilizer use in the present fertilizer distribution system. In an agro-socio-economic survey of farmers in the North West Province in 1982 conducted by the Testing and Liaison Unit of the National Cereals Research and Extension Project, it was found that credit ranked second only to labor among constraints limiting increased agricultural production by small farmers. In their sample 41.5% of farmers claimed to have used credit in the past; however, only 21.8% secured loans in 1982. The average loan was FCFA 109,766. The following sources of credit were used by farmers sampled.

Source of Credit	% of Farmers
Credit unions	34.5
FONADER	29.7
Cooperatives	16.4
Friends and neighbors	12.7
Banks	4.2
WADA	2.4

Recommended Fertilizer Marketing System

Need for Change

The present fertilizer distribution system has served Cameroon well by introducing and making fertilizers available to many farmers. To encourage food self-sufficiency and to earn foreign exchange from the sale of crops, the time has come to increase fertilizer consumption even more than what the present system has been able to do. The government is subsidizing the system heavily at the present time in areas of administration, procurement, transportation, inventory storage, losses, and product pricing. The cost of a typical fertilizer is estimated at FCFA 191,168/mt in 1985. The subsidized sector used 64,332 mt in 1984/85. At the above estimated cost and given a subsidy rate of 79.1%, the budget requirement was FCFA 9.73 billion in 1984/85. When fertilizer consumption is small, the cost to the government is small. When consumption becomes large, the cost likewise places an increasing financial burden on government resources. Because of this continuing financial and manpower drain, government-managed marketing systems will not rapidly expand fertilizer sales. The present fertilizer distribution

system has so many problems with structure and constraints that a new and complete fertilizer marketing system is needed to overcome the constraints to fertilizer use and increase fertilizer consumption to the desired level.

A government by nature of its primary responsibilities is usually not structured or managed to operate on a commercial basis. Governments perform strategic planning, formulate policy, and respond directly to social concerns. Activities that cannot be operated on a self-sustaining basis must remain a function of the government. As many operational activities as possible need to be operated by the private sector. The conclusions reached by the study team is that it is time for the Government of Cameroon to relinquish operational control and shift to a self-supporting commercial system for the fertilizer sector.

The recommended fertilizer marketing system is designed to increase fertilizer sales and food-crop production. This will be accomplished through the widespread use of promotional activities, i.e., research, demonstrations, field days, advertising, training, etc. The system will make the right fertilizers available to farmers on a timely basis. There is a synergistic effect when all components are implemented together. These activities will more than offset the adverse effects of an increase in price caused by reducing the fertilizer subsidy. By eliminating the subsidy the government can use these funds to support the fertilizer marketing system in other ways.

Concepts

Several different marketing concepts, organizational structures, and methods of ownership were evaluated in designing the recommended marketing sytem.

The concepts used by the Recommended Fertilizer Marketing System (RFMS) would be as follows:

1. Establish objectives for long-term growth.
2. Develop a strong competitive position.
3. Develop the entire fertilizer market.
4. Seek new opportunities for additional product lines.
5. Develop personnel to a high professional level.
6. Operate at a reasonable profit and lower the cost of fertilizer to farmers.
7. Recognize that the firm operates in a medium-risk environment.
8. Provide all fertilizer nutrients needed according to soil and crop conditions in the most economical forms and manner.
9. Market crop production programs and encourage the adoption of an appropriate package of practices by farmers.

10. Establish a channel to reach small farmers who buy a bulky product infrequently and in small amounts. They also require other essential inputs to achieve benefits from their purchase of fertilizer.
11. Develop an intensive and strong promotional program to encourage the proper use of fertilizers at the farmer level.
12. Require all retailers to adhere to government policies on product pricing.
13. Obtain favorable policy decisions from the Cameroon Government whereby the recommended fertilizer marketing system can operate efficiently within the existing environments.
    a. Ensure that there are at least two fertilizer companies and that each has its own supply of fertilizer raw materials and is experienced in market development. The companies will be authorized by the government to provide all the required fertilizer needed to meet demand at the farm level. Other companies may come into operation as business justifies their existence. The companies will have unrestricted rights to import fertilizer and materials required to meet demand.
    b. Encourage each company to develop an independent franchise-type retail network to service the demand and to encourage competition at the local level. The marketing organizations will be authorized to have complete freedom to determine their retail network and to establish the criteria for their retailer selection.
    c. Authorize the companies to hire, promote, and fire personnel in keeping with established private industry norms in Cameroon.
    d. Allow the companies to establish career development programs and ensure training for the advancement of each employee.
    e. Allow each company to assume responsibility for its own promotional activities with regard to market development.
    f. Base subsidy payments on total cost. Subsidy payments should be made directly to the company.
    g. Authorize each company to enter into the production and marketing of other inputs including ground limestone, gypsum, other soil amendments, pesticides, and other crop production inputs as it may deem necessary to achieve the company's objectives.
    h. Authorize each company to purchase crop produce through retail networks.
    i. Authorize each company to acquire capital from local or international sources as required to operate efficiently.

j. Ensure that the companies exist as legal incorporated entitites and thereby are responsible for their actions.

Organization of the RFMS

On the basis of these concepts and policies, the RFMS envisions the establishment of a commercial company which would operate with specific marketing targets and in a competitive environment under a responsible manager. It would consist of at least four functional units: marketing, production, finance, and personnel. It would benefit from strategic planning and could be planned as an autonomous, self-supporting commercial company.

The marketing management of the recommended system should collect specific data going beyond a broad scanning of the micro- and macro-environment and its general understanding of how farmers and fertilizer systems work. To gain real insight into the future for Cameroon fertilizer, the company will need to undertake formal marketing research and information gathering. Such research is an indispensable part of modern marketing management. An ongoing forecasting and internal information system is essential for a day-to-day program of sales and distribution. Marketing practice calls for dividing the market into major market segments, i.e., retail and wholesale channels. Because the wholesale (nonsubsidized) channel to plantations and parastatals provides much of its own technical and agronomic services, this channel can be covered with little expenditure of company support resources. The small farmer can be reached through a series of locally owned and operated input supply organizations having a retail network (dealers). This would be a retail channel and receive full support from the company.

Many factors influence the strategy to be pursued by the marketing arm of the recommended company (Figure II-6). The resources of each channel are focused on the end users. These resources are controllable variables and have been grouped into four elements: P_1 = product quality; P_2 = price; P_3 = place; and P_4 = promotion. At any one time, these resources can be budgeted. The optimum weight assigned to each element in this marketing mix (Figure II-7) must be in keeping with the company objectives and the needs of each channel. These can be adjusted in the planning cycles. The organization can increase the number of its retailers and raise its sales promotion efforts in the short run. The development of markets for new products occurs over a longer period.

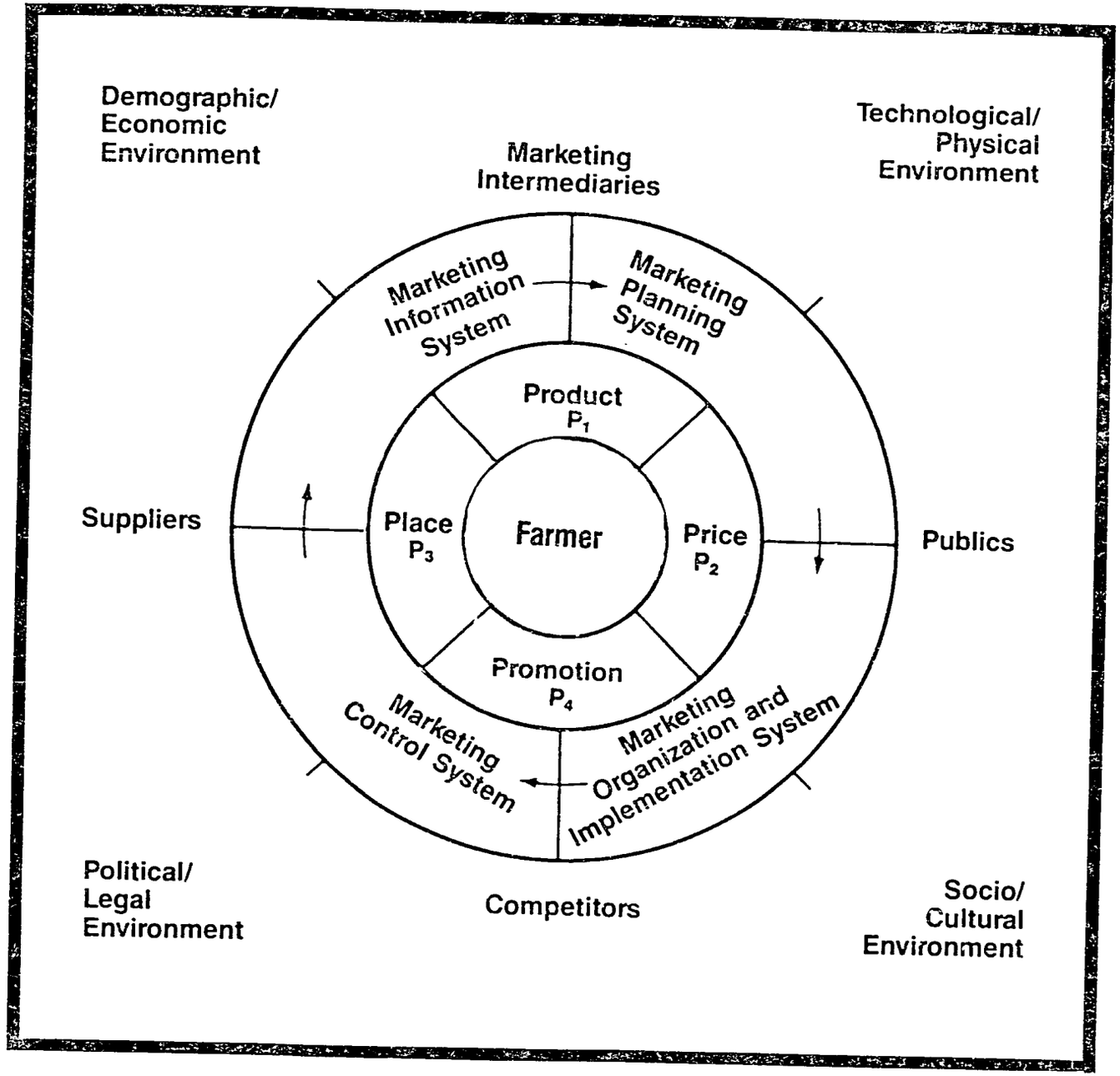


Figure II-6. Factors That Affect the Recommended Fertilizer Company's Marketing Strategy.

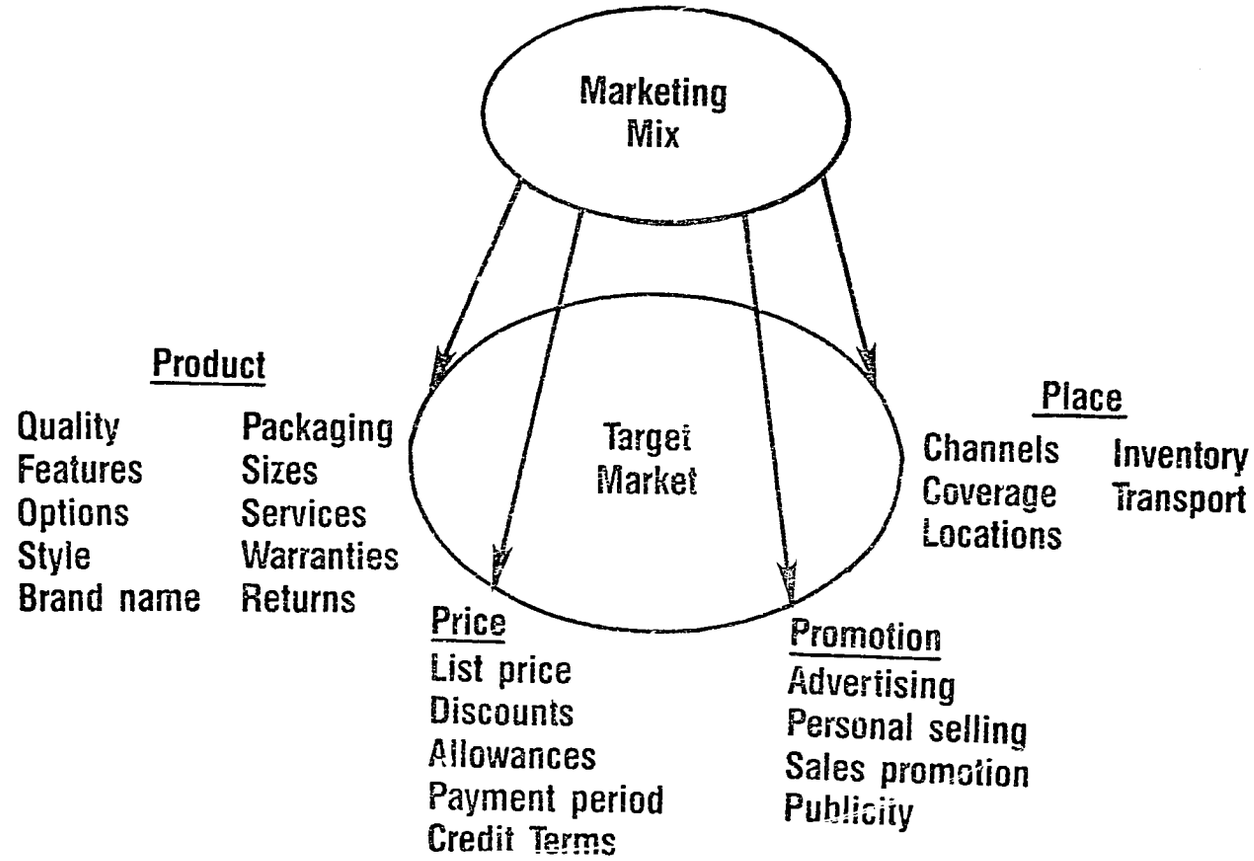


Figure II-7. Variables in the Fertilizer Marketing Mix.

The RFMS will offer a slate of fertilizers and perhaps other crop production inputs. Each product will have special features, packaging, branding, development, and servicing policies. These must be enunciated in an annual plan. Another important marketing decision variable is price. The recommended marketing organization will submit its recommended price for each product to the Ministry of Planning for approval as long as fertilizers remain under direct subsidy. Place stands for the various activities that the company must undertake to ensure that the right product is in the right retail outlet at the right time to meet the needs of the target customers in each channel. The company must identify, recruit, and link retailers, facilitators, and supply sources so that its product-service components efficiently reach the market. Promotion stands for the many activities undertaken by the company to communicate the merits of its crop production programs to customers and to persuade the customers to buy them. The company plans and operates a wide range of sales promotion activities; arranges publicity; dispatches sales staff to solicit orders; develops literature, media material, and point of sale items; and buys advertising to promote its crop production program and fertilizers. These activities are enunciated in detail in the annual marketing plan.

Experience has shown that the strongest fertilizer companies in the long run are the ones that have supply and marketing responsibilities under a single management body. The recommended fertilizer marketing component of the company takes advantage of this concept.

Organizational Structure

The first step in designing a marketing system is to determine the corporate and marketing objectives and develop an organizational structure that will allow the system to function effectively. Each function that is to be carried out within the organization contains an inherent responsibility to help accomplish the marketing objectives.

Channel Functions

1. Supplies will be obtained in quantities required to meet individual company needs. The competing companies will of necessity purchase fertilizers at the most advantageous periods at world market prices.
2. Licenses to import supplies will be provided by the Ministry of Commerce and Trade or its agency to cover the quantities of fertilizers required. The license to import will be provided on a timely basis and without unnecessary cost and delays.

3. Quality control will be maintained. Uniform fertilizer laws should be instituted. A national agricultural organization with staff posted in the field should have responsibility for implementing the control laws. This organization will make chemical analyses of fertilizers offered for sale to farmers to ensure guaranteed analysis and will determine bag weights to ensure that proper weights are reaching the farmer. The organization will conduct studies and monitor the marketing system to ensure proper fertilizer pricing and competition at local and national levels.
4. Wholesale channel will be determined by the company marketing staff on a value basis. Several large parastatals and plantations will be sold fertilizer on a wholesale basis. The wholesalers by contract will not be authorized to resell fertilizers to retailers or to other farmers. Possible current wholesaler accounts would include SODECOTON, CDC, HEVECAM, SOCAPALM, PAMOL, SEMRY, and ANACAM.
5. Retailers will be selected according to established criteria by the company marketing staff. See Appendix I for a list of the types of criteria that should be considered. The retailers will store, sell, and promote the use of fertilizer at the farmer level. The retailer will be the focal point for developing the fertilizer business in Cameroon. Retailer educational programs will be provided by the company marketing staff. Retailers will be expected to attend training sessions. Retailers will be expected to help farmers acquire a supply of all needed inputs and a place to market crop produce.
6. Farmer satisfaction is the end result of all activities to be carried out by the marketing organization.

Annual Marketing Plan

When the company is formed, one of the first activities should be to prepare a detailed 5-year marketing plan which will include seven component plans: (1) products, (2) sales, (3) promotion, (4) marketing research, (5) distribution, (6) price, and (7) personnel development. The weight to be given each determines the marketing mix. Each year the fifth-year plan is added and the approaching year's plan is updated for implementation. Key features of the plans are briefly discussed to offer an additional means of understanding component parts of an effective marketing system.

1. Product Plan--An annual product plan should be based upon research findings and improved practices. The product slate should be selected to meet the farmers' requirements. The plan will include product and package specifications, brand, and product identification.

Current research data, as discussed in Section I, provide the basis for the product slate. The agronomic requirements for crop production in Cameroon at present can be met with grades of fertilizers having a 2:1:1 and 1:3:1 ratio plus additions of urea and potash where needed. Thus, the following product slate has been selected:

20-10-10

10-30-10 + 5S

13-26-13 + 5S + 1B

19-19-10 + 5S + 1B

Urea

Muriate of potash (KCl)

Methods for supplying the recommended slate of products are described in the section entitled "Technical/Economic Assessment of Fertilizer Supply Alternatives." These methods include importing compound and straight materials in bulk and bagging them locally in addition to bulk blending a number of materials to obtain the recommended nutrient ratios.

In Phase I--year 1987, the product slate stipulates that 6,000 mt of fertilizers will be imported and supplied to the new recommended marketing company. This will be used primarily to test the system. In Phase II, 1988, 50,000 mt of product will be imported; one-half is to be in bulk and bagged in-country. In Phase III, 70,000 mt of bulk fertilizers will be imported and bagged in-country. In Phase IV, 90,000 mt of bulk fertilizers will be imported and bagged in-country. During Phase V, enough material to produce 110,000 mt of product will be imported and bagged, either as bulk blend or straight material, depending upon the feasibility of bulk blending.

2. Sales Plan--The sales staff, utilizing available information from each retail and wholesale account, will forecast the tonnages of each product required and the time it will be needed. On this basis the sales plan establishes sales objectives and means of accomplishing the objectives. The country will be

divided into sales zones and territories as required for effective management. A sales representative will be employed for each territory. The sales plan will be prepared by the sales representative and will contain a sales forecast by retailers, by products, and by time periods.

A detailed sales forecast and plan can only be prepared after the staff has been stationed in the field and has begun to know the local situation.

Target Markets--The company during Phases I-IV should concentrate on crop production programs for the subsidized and food-crop markets. The 20-10-10 will be continued for coffee and will be used as a general type of fertilizer by those that do not sidedress with urea and ammonium sulfate.

The company will introduce a crop production program featuring 10-30-10. It is high in phosphate and makes a good basal application for most crops. The extra nitrogen required can be added by sidedressing with urea. Through promotional efforts the company will increase urea sales.

One of the grades the company expects to start phasing out in 1987 is 12-6-20. Where more potash is needed, 0-0-60 will be marketed.

Parastatals and plantations will continue to use such grades as 10-10-20, 15-15-15, 15-20-15, and 22-10-15 which can be supplied from the company bagging facility.

In Phase IV, the company will commence a sales program through the wholesale channels that will offer locally blended products like 13-26-13 + 5S + 1B and 19-19-10 + 5S + 1B. The compound fertilizer 13-26-13 + 5S + 1B, will be targeted for wet cotton-growing areas where sidedressing with urea can be done on a practical basis, and the 19-19-10 + 5S + 1B is for the dry cotton-growing area where sidedressing is not as practical from an agronomic viewpoint. By Phase IV, in 1990, there is a possibility of selling to the parastatals and plantations. By 1991 this figure should increase. This should increase as bulk blending becomes possible.

If the recommended changes are adopted, the fertilizer consumption in the entire subsidized fertilizer sector is estimated to be as follows:

Estimated Fertilizer Consumption for the Currently Subsidized Sector[a]

Year	Fertilizer Grades				
	20-10-10	12-6-20	10-30-10	Urea	AS
1987	46,085	8,000	0	22,277	11,181
1988	50,749	2,999	3,999	24,261	10,238
1989	37,487	-	7,998	34,747	9,300
1990	36,453	-	12,000	40,028	8,364
1991	37,391	-	16,002	44,958	7,431

a. At the present benefit/cost ratio.

3. Promotion Plan--Promotion includes personal selling and educational programs, i.e., field days, farmer meetings, demonstrations, soil testing, posters, etc., as well as research programs, advertising, and sales promotion activities. Objectives for each of these activities will be included in the annual plan by time periods and methods of accomplishing each. The promotion activities are essential to expand fertilizer marketing and encourage farmers to shift to better farming practices. The agronomic staff, salesmen, and retailers will assist with developing and carrying out the promotional activities.

4. Market Research Plan--Accurate base data are essential for planning and operating a successful marketing organization. Upon formation each company should start a plan for collecting and verifying data that are required for planning and guiding future marketing operations. This responsibility, even in a small company when a full-time market research staff is not practical, should be assigned to specific staff members.

5. Distribution Plan--Based upon the sales forecast, an annual distribution plan is prepared as an element of the annual marketing plan. This plan will utilize contracts with railways, trucking firms, warehouses, and ports to accomplish objectives. The plan should achieve a balance between the economics of the operation and such factors as the level of service, warehousing, and frequency of handling. A traffic analysis should be made. The costs are determined and the level of service established in consultation with the Sales Department. The annual distribution plan should show inventory management, documentation information, the modes of transportation, delivery schedule, the

storage requirements, the primary delivery points, the means of in-transit control, and the national freight and storage budgets. It should establish the essential liaison with accounting, sales, and supply functions and should also establish communication procedures.

To provide assistance with making and operating a distribution plan, a detailed discussion of important issues follows in the section entitled "Physical Distribution Factors."

6. Price Plan--The creation of two or more companies to supply products and market them in the most cost efficient manner will not fully guarantee expanded fertilizer consumption and increased crop production. A sound pricing policy to provide adequate economic incentives to all concerned in the marketing system is essential. The price plan identifies and recommends the company terms of sale and needed government action required for accomplishing the objectives. The price plan should also include marketing margins, fertilizer prices, and the role of subsidies at each stage within the marketing chain. The price plan should be directed toward a free-market pricing policy by phasing out subsidies on a practical basis.

The marketing margin for the company can be determined only after actual costs are known. A normal guideline would be a net return to the company of approximately 4%-5%. This is considered a minimum requirement to attract the best fertilizer companies to Cameroon. Savings in the current system can be made to cover the marketing margin and still maintain the FCFA 191,168/mt price to farmers at the retail store.

The fertilizer retail prices are determined by using the cost-plus approach. The approximate retail price FCFA/mt for each product can be determined as follows:

Ex-Supply Price

c.i.f. price
Port handling charges
Bags, bagging, loss, and handling
Blending cost
Insurance
Warehousing cost

Wholesale Price

Ex-supply price
Primary transportation cost
Company warehousing cost
Secondary transportation cost
Fertilizer loss in transit
Interest on working capital
Administrative cost
Promotion cost
Marketing margin

Retail Price

Wholesale price
Retailer's commission to cover functions performed

The estimated current cost at retail amounts to FCFA 191,168/mt (see Table II-9). This is based on a uniform freight rate and a uniform retail price policy. The RFMS can most likely operate within these costs and through its organization have a reasonable margin. The estimated retail price is expected to cover all the cost of marketing functions performed at retail level and earn a nominal rate of return on investment, thus making the fertilizer system self-sustaining financially. A retailer's margin of FCFA 10,000-15,000/mt is recommended. With this margin the retailer must pay all retail costs of doing business, i.e., storage, promotion, losses, interest, etc. The margin should provide the retailer a net return on investment of approximately 3%. A quantity discount arrangement to provide retailers with an incentive program should be considered. The pricing policy should be reviewed when the company is operational and fertilizer sales increase.

An objective of the recommended fertilizer marketing system to be implemented by the company is to increase fertilizer sales and food production. The savings through efficiency in physical distribution as compared to the present system will be utilized in market development, i.e., promotional programs, facilities, demonstrations, etc. The price of fertilizer will not necessarily be less per ton of product although it will be less per nutrient ton as explained

in the section on savings the system can offer. The recommended marketing system has forecast an average selling price per ton of product during Phases I-IV at FCFA 191,168 or $477.92 in constant 1985 prices. This is at the present cost of marketing fertilizers. In Phase V the average price of fertilizer should increase by FCFA 3,832/mt to FCFA 195,000/mt or $487.50/mt to cover estimated increases in cost of fertilizer materials.

Fertilizer for the most part is profitable for food-crop production in Cameroon. At present crop and fertilizer prices, the benefit/cost ratios for most crops appear favorable. With the elimination of the subsidy, fertilization at the recommended rate will still be favorable for most crops if the other inputs and management practices are followed. As the subsidy is removed, the same minimum benefit/cost ratio should be maintained or made better through increased crop prices to keep the incentive favorable for the farmer. See the section on "Economics of Fertilizer Use" for details. Attention needs to be given to the farmer price for coffee. Some of the current benefit/cost ratios for crops, as estimated by consultants and presented in Section I, Part I, are:

Crop	Subsidized	Nonsubsidized
Arabica coffee	3.98	1.49
Robusta coffee	2.48	0.68[a]
Maize	5.03	1.88
Rice	6.66[b]	2.88[b]
Sorghum	2.04	-
Cotton	-	Favorable

a. Not profitable.
b. Both irrigated and nonirrigated rice.

7. Personnel Development Plan--The company will only be as good as the people employed to represent it. The personnel department will have the responsibility of screening and bringing into the company personnel who have the ability to perform their assigned task. The function of the company training program is to enable each employee to attain his greatest level of performance. The personnel development plan should identify training targets for all company personnel and the different training means to meet them. Training requirements for managing the recommended marketing system are given in the section on "Additional Infrastructure Required to Support the Recommended Fertilizer Marketing System."

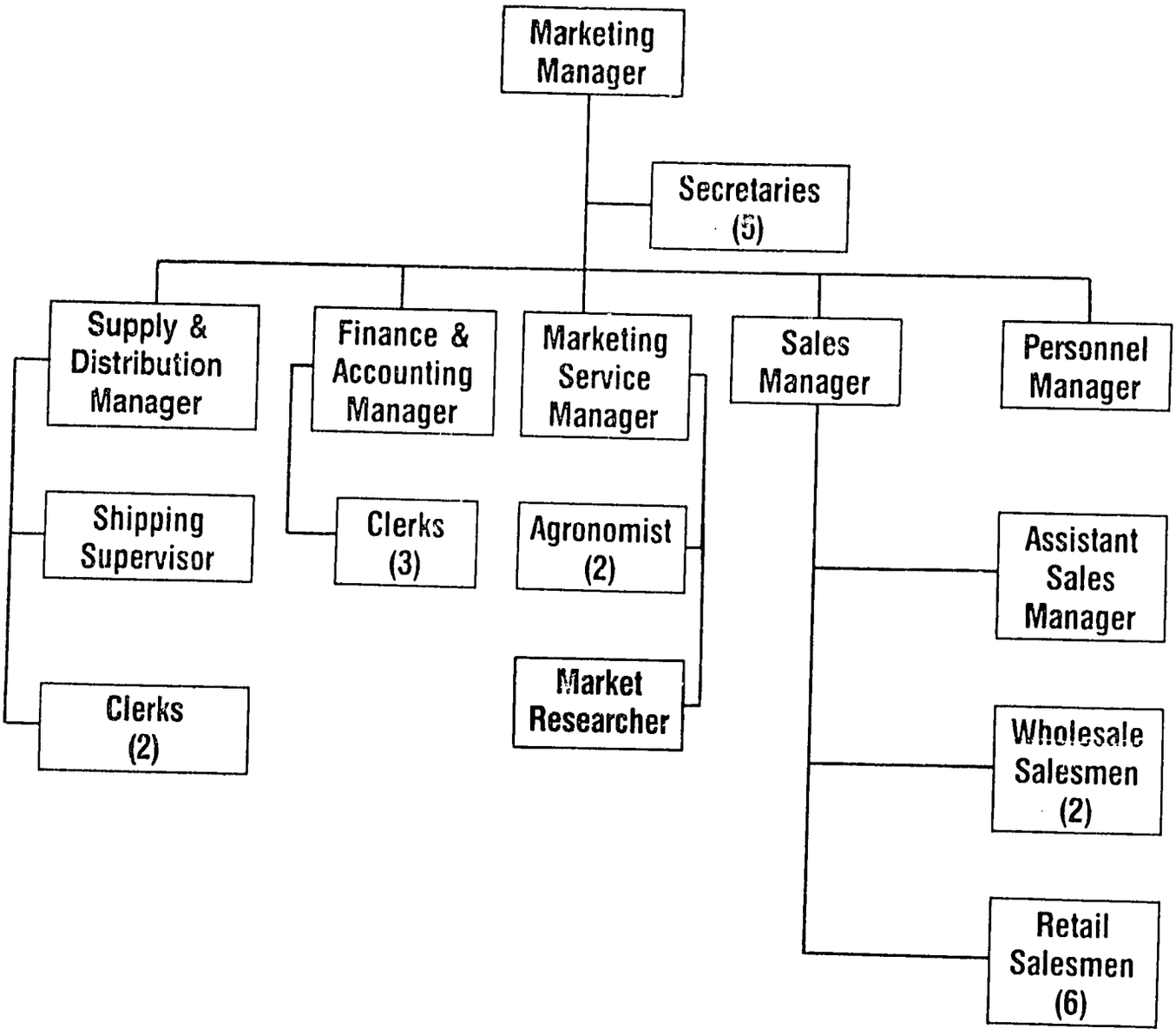


Figure II-8A. A Model Commercial Fertilizer Organization Having Application for Cameroon.

Staffing

A model organization that is responsible for fertilizer marketing, which has application for Cameroon, was used to prepare cost estimates and is shown in Figure II-8A. The model calls for a staff of six (6) for the following positions:

1. Marketing Manager (General Manager).
2. Supply and Distribution Manager.
3. Finance/Accounting Manager.
4. Marketing Services Manager.
5. Sales Manager.
6. Personnel Manager.

It is suggested that these key positions be filled with expatriates until such time as nationals can be trained to take over the responsibilities. The Supply and Distribution Manager should be given combined responsibilities until such time as the volume of business or bulk-blending and bagging operations can justify dividing these staff functions. Plant operating staff for in-country bagging have not been identified in the product plan; however, this has been costed and is included in the ex-factory price. The following phasing calendar indicates periods of services before being phased out.

It was estimated that the following field staff would be required:

1. Two agronomists.
2. One assistant sales manager.
3. Six field salesmen.
4. Two wholesale salesmen.
5. One market research supervisor.
6. One shipping supervisor.
7. Five clerks.
8. Five secretaries.

Support staff, i.e., guards, drivers, maintenance, etc., will be added as needed.

Additional staff may be required and added as markets are developed. First consideration is for sales and field staff working at the retail level. With development of the fertilizer production component, the structure would be modified as shown in Figure II-8B.

Phasing of Recommended Fertilizer Marketing System

The first step in building a self-supporting fertilizer sector is to obtain commitment from government to withdraw from those fertilizer marketing

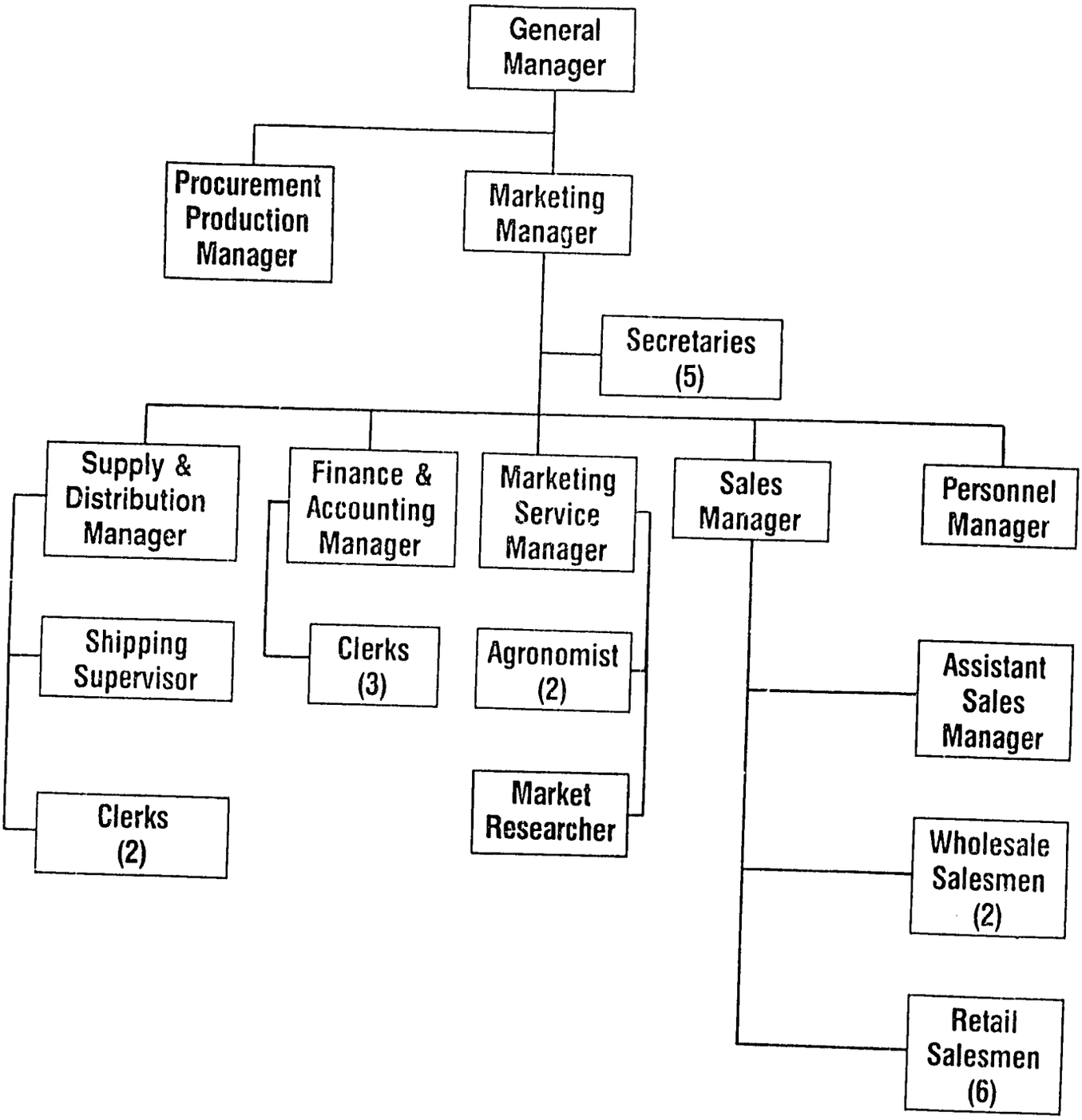


Figure II-8-B. A Model Commercial Fertilizer Organization Having Application for Cameroon.

activities that can best be carried out by private industry. The commitment should include the approval for establishing the commercial companies. Without this commitment, privatization of the fertilizer sector cannot be accomplished. The government can provide leadership in privatizing the fertilizer sector by educating the public on its intentions to have a self-supporting fertilizer sector and establishing a time-frame for government withdrawal from marketing activities.

A new fertilizer marketing company takes time to build and become fully operational and efficient. Phasing in the organization on a scheduled basis can save resources in the long run. A primary objective of a phasing period is to transfer the responsibilities of purchasing, distribution, supply, pricing, and promotion from public institutions to a private self-supporting marketing system guided by a profit motive. The following phasing calendar is offered as a guide in building an effective system.

Phase I (12-18 Months), Year 1 = 1987

1. Create company
2. Structure organization.
3. Hire and train staff.
4. Develop a marketing plan.
5. Commence retailer selection.
6. Commence retailer training.
7. Develop a financial plan.
8. Import 6,000 mt of fertilizers (8% of forecasted subsidized fertilizer consumption. The remaining 92% will be handled by the present system).
9. Commence engineering for bagging support facilities.
10. Commence retailer/farmer educational activities and agronomic field testing.
11. Leave subsidy and fertilizer sale price unchanged.
12. Have company collect difference between subsidized price and the total delivered cost from government as a part of a grant or low-cost loan.

Phase II (12 Months), Year 2 = 1988

1. Continue retailer development.
2. Begin construction of bagging facilities.
3. Optimize distribution and warehousing facilities.
4. Develop next year's marketing plan.
5. Develop a financial plan.

6. Import 50,000 mt of fertilizer bagged--one-half local bagging if possible (62% of forecasted subsidized fertilizer consumption. The remaining 38% will be handled by the present system).
7. Commence a sales promotion campaign.
8. Continue training programs for staff.
9. Continue agronomic activities.
10. Reduce subsidy from 79.1% to 63.3% of actual total delivered cost.
11. Have company collect difference between subsidized price and actual total delivered cost per ton.

Phase III (12 Months), Year 3 = 1989

1. Expand sales staff.
2. Develop next year's marketing and finance plans.
3. Continue retailer and staff training.
4. Expand retailer network.
5. Import 70,000 mt of bulk fertilizers for in-country bagging (82% of forecasted subsidized fertilizer consumption. The remaining 18% will be handled by the present system).
6. Phase out four expatriate staff and replace with nationals.
7. Intensify sales promotion activities.
8. Examine bulk-blending potential.
9. Intensify agronomic/educational programs.
10. Reduce subsidy from 63.3% to 47.5% of actual total delivered cost.
11. Have company collect difference between subsidized price and actual total delivered cost from government.

Phase IV , Year 4 = 1990

1. Continue expansion of retailer network.
2. Continue training of retailers and staff as needed.
3. Prepare next year's marketing and financial plans.
4. Optimize sales promotion activities relating to advertising, education, and research.
5. Install bulk-blending facilities if determined feasible.
6. Import 90,000 mt of bulk fertilizers (100% of forecasted subsidized fertilizer consumption).
7. Continue agronomic educational programs.
8. Reduce subsidy from 47.5% to 31.7% of actual total delivered cost.

9. Have company collect difference between subsidized price and actual total delivered cost from government.
10. Start a sales program with wholesale accounts.

Phase V, Year 5 = 1991

1. Continue expansion of retailer network.
2. Continue training of company staff and retailers.
3. Develop marketing and financial plans for the next year.
4. Import 110,000 mt of bulk materials (116% of forecasted subsidized fertilizer consumption plus introduction sales to the nonsubsidized sector).
5. Continue educational programs for retailers and to farmers.
6. Optimize sales promotion programs.
7. Reduce subsidy from 31.7% to 15.9% of total delivered cost.
8. Have company collect difference in subsidized and actual total delivered cost from government.
9. Intensify wholesale programs.

Capitalization

The company will need to be capitalized. A procedure for this is to form a joint venture private company that can be capitalized through grants or low-cost loans from external sources to the Government of Cameroon. The GOC will use loan funds to acquire shares in the joint venture company. A U.S. fertilizer company basic in fertilizer materials and with a proven record of market development should be solicited to purchase shares in one of the joint venture companies. The advantages of a joint venture with a U.S. firm would include the following: (1) access to experienced management skills for fertilizer manufacturing and marketing; (2) proven experience in market development especially involving services needed by small farmers; (3) availability of appropriate fertilizer materials direct from a primary producer; (4) experience in the manufacture of all types of fertilizers including bulk blending; (5) facilities for the simplification of the logistics of supply; (6) experience in forecasting demand for fertilizers and its synchronization with supply sources for maximum cost effectiveness; (7) ability to train a cadre of national personnel for efficient fertilizer sector operation; (8) experience in private sector operations; (9) stability in fulfilling contractual objectives; (10) a source of capital for the venture.

The capital requirements by phases are shown in Table II-14. These requirements cover the entire cost of marketing, i.e., management, product,

Table II-14. Capital Requirements by Expense Items and Phases for the Recommended Fertilizer Marketing System

Items	Phase I	Phase II	Phase III	Phase IV	Phase V
	(million $[a])				
Expatriate staff	1.00	0.67	0.32	0.32	0.16
National personnel	0.46	0.42	0.44	0.45	0.47
Equipment	0.10	0.01	0.02	0.01	0.01
Distribution	0.47	3.96	5.54	7.12	8.70
Office	0.02	0.02	0.14	0.13	0.18
Vehicles	0.24	0.19	0.20	0.25	0.27
Promotion	0.10	0.20	0.28	0.36	0.44
Fertilizers[b]	1.50[c]	12.50[d]	17.50[e]	22.50[f]	27.50[g]
TOTAL	3.89	17.97	24.44	31.14	39.05

a. Calculations made in constant 1985 US $; to convert to FCFA multiply by a factor of 400.
b. Fertilizer calculated at US $250/mt, c.i.f. Douala.
c. 6,000 mt.
d. 50,000 mt.
e. 70,000 mt.
f. 90,000 mt.
g. 110,000 mt.

Source: IFDC consultants' estimates.

distribution, and promotion at estimated delivered prices based on constant 1985 prices. The total expenses in Phase 1 representing one and one-half years amount to US $3.89 million. These expenses cover the cost of importing 6,000 mt of fertilizers equal to $1.5 million and marketing startup costs such as employment training and posting of personnel, selection and training of retailers, and establishment of a physical distribution system. The expenses accelerate during Phases II-IV because of the increased cost of the fertilizer tonnage required for sales. In Phase IV, 90,000 mt of fertilizer will be needed for sales. The system reaches a breakeven point during Phase II with revenue generated from the sale of 50,000 mt of fertilizers. The revenue generated from fertilizer sales is shown in Table II-15. In Phase II revenue generated amounts to US $23.90 million and sales expenses amount to US $17.97 million. The revenue reaches US $53.63 million during Phase IV with marketing expenses of US 39.05 million. Figure II-9 A, B, and C graphically shows the expenses, revenue generated from fertilizer sales, and the removal of the subsidy by phases.

Subsidy

It is recommended that fertilizer subsidies be phased out completely during the first five phases of the project. The present 79.1% subsidy was calculated by determining the actual total cost of a typical ton of fertilizer delivered for sale at the retail level (FCFA 191,168). The actual cost paid by the farmer at the official price (FCFA 40,000) was subtracted from the retail cost. The difference between the two was divided by the actual retail price. During Phase I the present 79.1% subsidy should continue. It is recommended that the subsidy be reduced thereafter at the rate of 15.8% per year until at the end of Phase V and by the beginning of Year 6 it has been totally eliminated as shown in Figure II-9 C. The difference between the subsidized price and the actual marketing cost per ton is to be collected from the government and paid directly to the company headquarters. The amount of money collected from the GOC is equal to the total delivered cost of a typical fertilizer (in 1985 US $477.93/mt) minus the amount paid by the farmer at retail level. Table II-15 shows the reduction in subsidy and the amount of money to be collected from the government. The total reaches a high of US $15.88 million in Phase III and reaches zero after the fifth phase.

Savings

In Phase V the company will be selling an average ton of fertilizer at FCFA 195,000/mt (based on constant 1985 prices). This represents an increase of

Table II-15. Comparison of Fertilizer Sales by the Recommended Marketing System With Current Forecast of Subsidized Sales, Reduction in Government Subsidy, Revenue Generated by the Recommended Marketing System, Marketing Expenses and the Subsidy Paid by the Government, by Phases

(1) Phases	(2) Year	(3) Current System Forecast of Subsidized Sales ('000 mt)	(4) Recommended System Forecast of Subsidized Sales ('000 mt)	(5) Subsidy[a] (%)	(6) Recommended Marketing System Revenue[b] (million $)	(7) Recommended Marketing System Expenses[c] (million $)	(8) Difference Between Total Delivered Retail Cost and Subsidized Price[d] ($/mt)	(9) Total Subsidy Paid by Government[e] (million $)
I	1987	73.7	6.0	79.1	2.87	3.89	377.92	2.27
II	1988	76.0	50.0	63.3	23.90[f]	17.97[f]	302.42	15.12
III	1989	79.7	70.0	47.5	33.45	24.44	226.92	15.88
IV	1990	83.7	90.0	31.7	43.01	31.14	151.42	13.63
V	1991	88.0	110.0	15.9	53.63[g]	39.05	77.51	8.53
-	1992	-	-	0	-	-	0	0

a. Represents IFDC recommendation of a constant 15.8% annual subsidy reduction.
b. Figures obtained by multiplying figures in column (4) by $477.92/mt (or FCFA 191,168/mt) for Phases I-IV.
c. Figures from Table II-14.
d. Figures obtained by multiplying figures in column (5) by $477.92/mt for Phases I-IV and $487.50/mt for Phase V.
e. Figures obtained by multiplying figures in column (4) by those in column (8).
f. Breakeven period where revenue exceeds expenses by end of period.
g. Calculated at FCFA 195,000/mt or $487.50/mt times tons sold starting in Phase V.

Source: IFDC estimates in constant 1985 dollars.

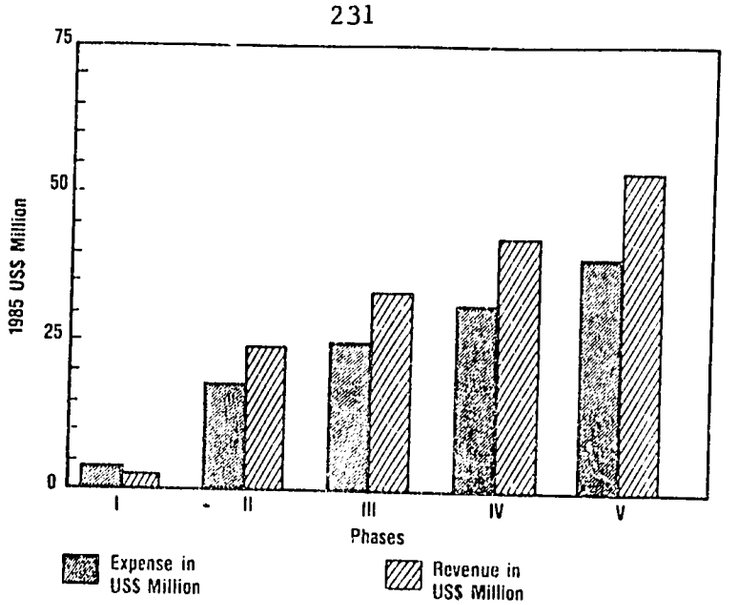


Figure II-9A. Recommended Fertilizer Marketing System (RFMS) Estimated Expense and Revenue by Phases.

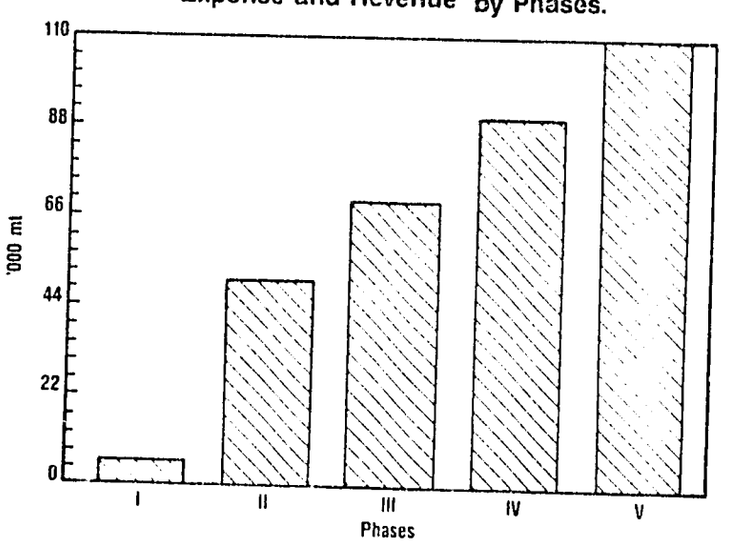


Figure II-9B. RFMS Fertilizer Sales Forecast by Phases.

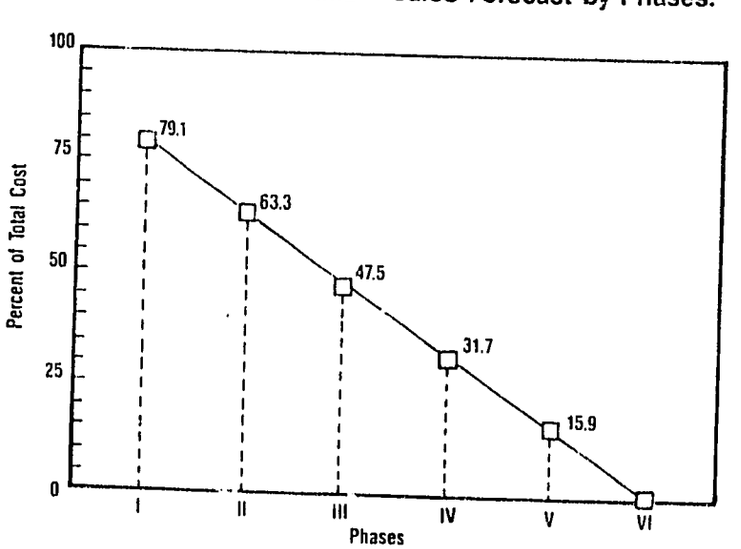


Figure II-9C. Recommended Fertilizer Subsidy Levels by Phases.

FCFA 3,832/mt above the average current fertilizer cost per ton. During this period and by year 1991, nutrient tons sold will increase from 38,356 to 46,221 mt or by an increase of 20.5%. This increase is computed by subtracting the total nutrients (in the tons sold of $N + P_2O_5 + K_2O$) in 1985 from the total nutrients in the tons sold in 1991. The difference is then divided by the total nutrients in the tons sold in 1985. Not only will the recommended system eliminate the cost of subsidy to government, it will also lower the cost of delivering nutrients to the farmer, introduce new fertilizers, and increase the availability of a timely supply of fertilizers to more farmers. The saving to the government due to the elimination of subsidy amounts to at least US $24.16 million or FCFA 9.66 billion (Table II-16) over the phasing period. This estimated government savings can be achieved by transferring the cost of the product from the government to the farmer over the five phases of the program. The price farmers pay per ton increases from US $100 in Phase I, the present situation, to the full cost of US $487.50 at the end of Phase V. This is a direct savings to the government. The saving in improving the distribution system alone amounts to at least US $36.15 million or FCFA 14.46 billion. The saving is computed by adding the savings that are possible through reduction in physical losses, nonpayments, and risk losses, diverse costs, and interest on cost of carrying inventory. The recommended marketing system provides other savings by eliminating government staff involvement in purchasing and distributing fertilizers. In summary, the proposed RFMS, when implemented, will save the government at least US $60.31 million or FCFA 24.13 billion. In addition, it should be reiterated that the proposed RFMS will be financially self-sustaining.

Physical Fertilizer Distribution Factors

Activities

Physical distribution activities involve the transporting, warehousing, materials handling, inventory planning and control, and the communications required to manage them (Figure II-10). These activities should serve as significant decision points in developing the marketing strategy. They create time and place utility, which maximizes the value of the fertilizers by delivering them when and where needed.

Table II-16. Some Government Savings (by Phase) Resulting From the Implementation of the Recommended Marketing System[a]

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Actual Delivered Retail Cost[b]		Government Savings Due to Subsidy Reduction		Cost Reduction Through Improved Distribution Efficiency[f]
Phases	Tonnages	Farmer Price ($/mt)	Government Contribution ($/mt)	Per Metric Ton ($)[c]	Total[e] (million $)	(million $)
I	6,000	100	377.92	-[d]	-[d]	0.665
II	50,000	177.51	302.42	75.51	3.77	5.545
III	70,000	251.02	226.91	75.51	5.28	7.763
IV	90,000	326.53	151.42	75.51	6.80	9.981
V	110,000	409.99	77.51	73.91	8.13	12.199
-	(undetermined)	487.50	0	77.51	(undetermined)	(undetermined)[g]
TOTAL					23.98	36.153

a. Calculated in constant 1985 prices.
b. Farmers' price plus government contribution is equal to actual total delivered cost of $477.92/mt for Phases I-V and $487.50/mt in Phase VI.
c. Government savings per metric ton is $75.51, i.e., 15.8% of $477.92 for Phases I-IV and 15.8% of $487.50/mt in Phase V. The difference represents the increase in price experienced by farmers in each phase.
d. In Phase I the current government subsidy rate of $377.92/mt continues; thus, there are no savings.
e. Figures in this column are determined by multiplying figures in column (5) by those in column (2).
f. Figures in this column are determined by reducing physical, nonpayment, and risk losses; diverse costs; and one-third of interest on cost of carrying inventory. These costs are estimated to be equal to FCFA 44,360/mt or $110.9/mt based on data in Table II-9.
g. Undetermined because forecasts of tonnages to be sold were not made.

Source: IFDC.

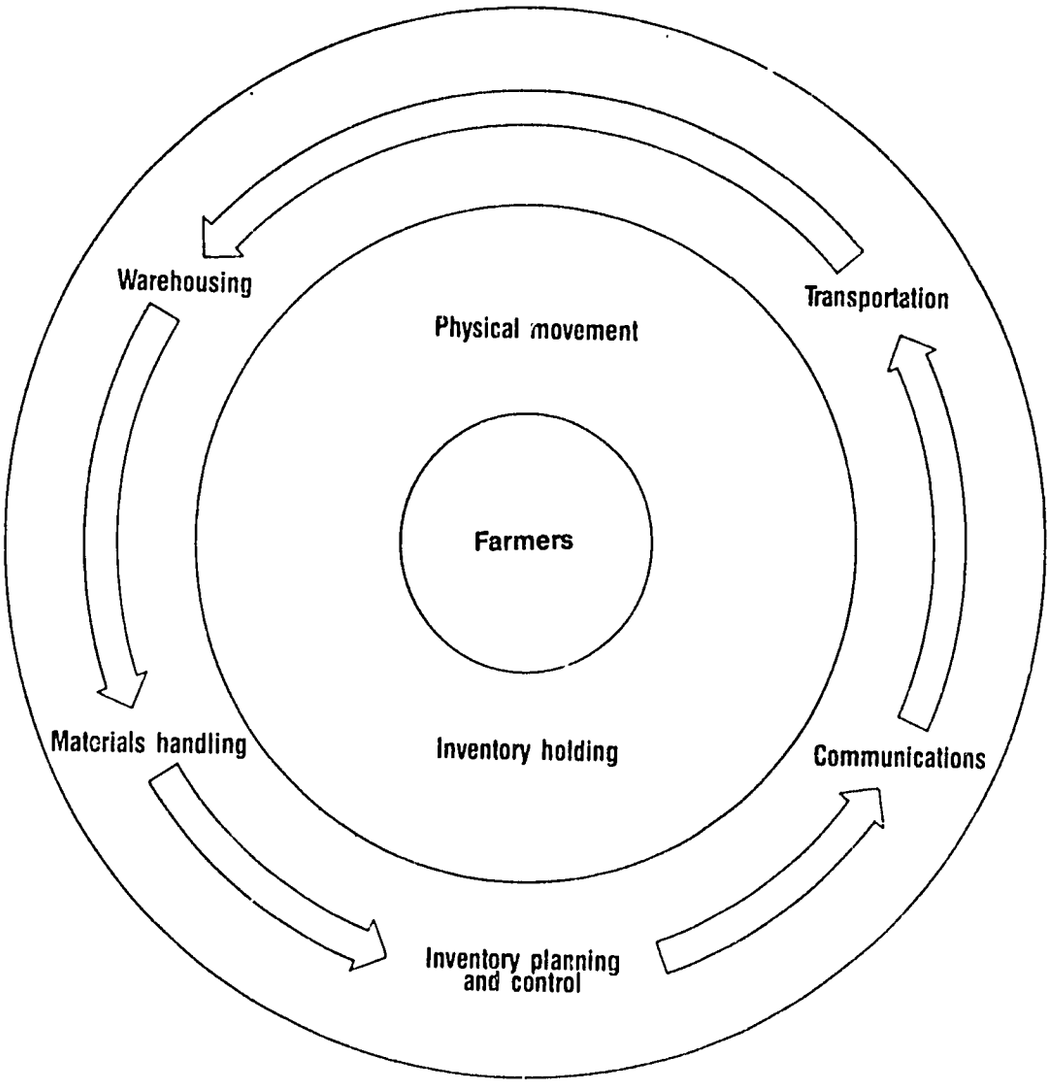


Figure II-10. Fertilizer Physical Distribution Activities.

The fertilizer inventory system should be planned so that the amount and kind of each fertilizer in stock can be determined on a continuing basis. The record of amount of each product in stock at each outlet needs to be updated monthly. A systematic method of determining efficient reorder levels should eliminate shortages (stockouts) and avoid having too much capital tied up in inventory.

Not all of the tonnage can be stocked at retail level. It is therefore necessary for the company to operate intermediate storage facilities at least in the early phases of the operation of the firm. The following essential processing functions should be performed by fertilizer warehouses: receipt of the various fertilizers, sorting of the fertilizers by grades and/or package sizes, dispatching of fertilizers, holding the products in an orderly manner, organizing a shipment, recording all transactions. During the early phases of the company operation, it is desirable to lease warehouse space rather than construct new facilities. A warehousing allowance could be paid to retailers for their construction of approved fertilizer facilities.

The physical handling of fertilizers is important in efficient warehouse operations, as well as from production plants to retail outlets. By selection of the appropriate procedures and techniques the usable capacity of a fertilizer warehouse can be increased.

Management of fertilizer movements requires that decisions be made during the production, storage, and delivery stages of operation. In the recommended marketing system, a key strategy is transportation of the products from production site in Douala to a primary distribution center on a continuing basis. Because of the broad network and conditions during the rainy season, fertilizers cannot generally be shipped directly from the production site to retailers. This increases the need for in-transit storage for the primary shipper at the end of the tarred roads. The fertilizers should be stored in transit warehouse until such time as smaller vehicles can haul the fertilizers on to secondary warehouses and retailers as a backhaul operation. During the dry season and when roads are passable, fertilizers can be shipped more directly down the distribution chain. The ability of the firm to provide delivery for the buildup of stock levels is a key benefit that farmers want. In the selection of a transport firm the following criteria should be considered: cost, transit time, reliability, capability, accountability, and security.

Because production occurs most economically on a regular and continuing basis and fertilizer is consumed seasonally, storage at some point in the total system is mandatory. Storage at the retail sales points has proven to be the

best. Access to retail outlets by vehicles used for the primary movement reduces the number of times the fertilizers are handled. The quality of the fertilizer can be preserved. Packaging, loading, and movement systems must be coordinated. The package must be designed to protect the fertilizers during the many handlings. The company plans to package the products in Douala. Research to identify the appropriate specifications for the packages to be used in the system will be required.

Many activities must be carried out in the physical distribution of fertilizers. These activities have been conceptionalized by interrelationships as shown in Figure II-11.

Information System

An information system for the physical distribution in the recommended marketing system should link the supply (producing) point, the company headquarters, field staff, and the retailers. Computers, memory systems, radio, telephone, and courier services serve to facilitate the flow of information among channel members. The information system serves to reduce costs and improve customer service. Forecasting of shipments and orders should be one of the principal functions of the field organizations.

A substantial organizational burden exists in managing the necessary documentation. A Management Information System (MIS) should be established within the Marketing Services Department. It performs six functions to maintain an orderly flow of information: data assembly, processing, analysis, storage and retrieval, evaluation, and dissemination. In addition to the forecasting of sales, the MIS should maintain a record of current freight rates and tariffs. Dispatch documents that should use the rate data should also be computerized. In addition, the revenue account, auditing procedures, and payment information should be automated. The data should be processed into managerial information and reports. Each field territory should be set up as a cost center so that all information concerning orders, payments, and functional costs--including those associated with physical distribution--can be ascertained and compared with the planned data. In addition, multiple-copy pro forma documents should be designed to simplify document preparation. In this way, the necessary copies of the bill of lading, freight bill, waybill, arrival notice, advice of shipment and delivery receipts can be made out simultaneously. In addition, the necessary information should be recorded and available for use in the preparation of invoices, statements, payment receipts, mailing lists, and summaries of activities.

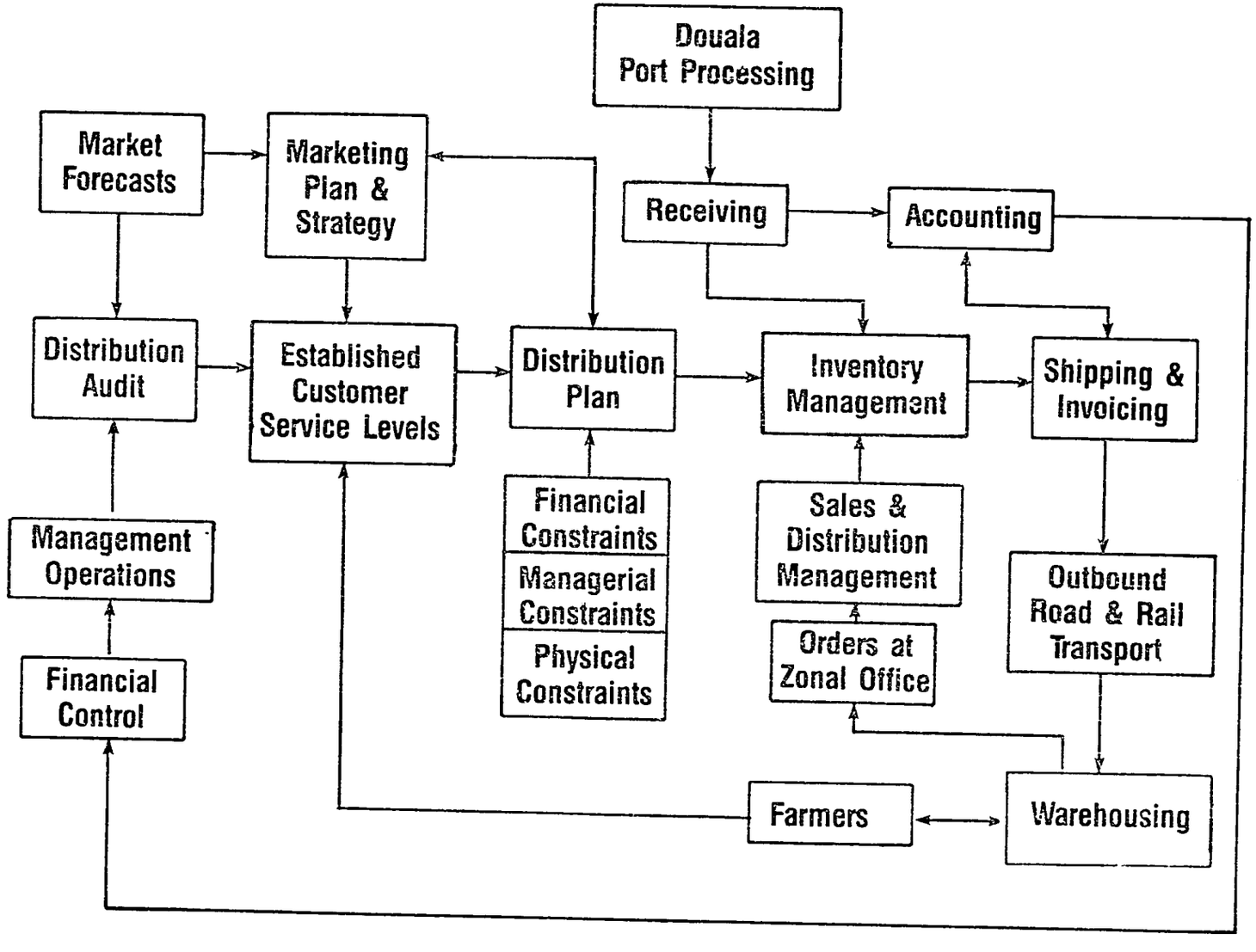


Figure II-11. Activities in the Physical Distribution System.

Because a sale involves the transfer of title it is of concern to carriers and insurers. Risk follows title. Carriers in the system should not have title but should have possession of the fertilizers and should possess liability for shipments. The bill of lading serves as a receipt for fertilizers and as a contract to transport them. It also serves as documentary evidence of title. Waybills should be used by carriers to facilitate the movement of the fertilizers. They should be prepared along with other documents to show the freight agent, the origin, destination, routing, truck or wagon initials and number, the consignor and consignee, the product grade, weight, rate, freight charges, and special notations regarding delay or damage to the shipment. The advice of shipment should be sent by the company to the consignee, and it should contain the same information that is on the waybill plus the expected time of arrival or free time allowed before demurrage is imposed. Even if notification is possible by radio or telephone, the document should still be forwarded. The delivery receipt contains the same information as the bill of lading. It is prepared in two copies: one for the carrier and one for the consignee. The carrier should obtain the signature of the consignee for his use, and the consignee should forward his copy to the marketing office for comparison with the shipping documents and the resolution of any claims. The marketing office should pay the carrier. The freight bill should contain information similar to that on the bill of lading and should show the total freight charges to be paid. In this system the distribution organization should pay the carriers within a 30-day period.

Seasonality of Fertilizer Consumption

To organize the physical distribution functions for the recommended fertilizer marketing system, the seasonalities of fertilizer consumption must be understood.

Timing of fertilizer application to the soil is dictated by climatic seasonality, primarily rainfall. The seasonality should serve as a basis for calculation of transport scheduling and storage requirements. For this calculation a definition of these steps is needed:

1. Time of application, use or consumption, is the month in which the fertilizer is used in the field by the farmer.
2. Time of sale or offtake is the month in which the fertilizer is received by the farmer. For these calculations this is assumed to be one month prior to application (see Figure II-12).

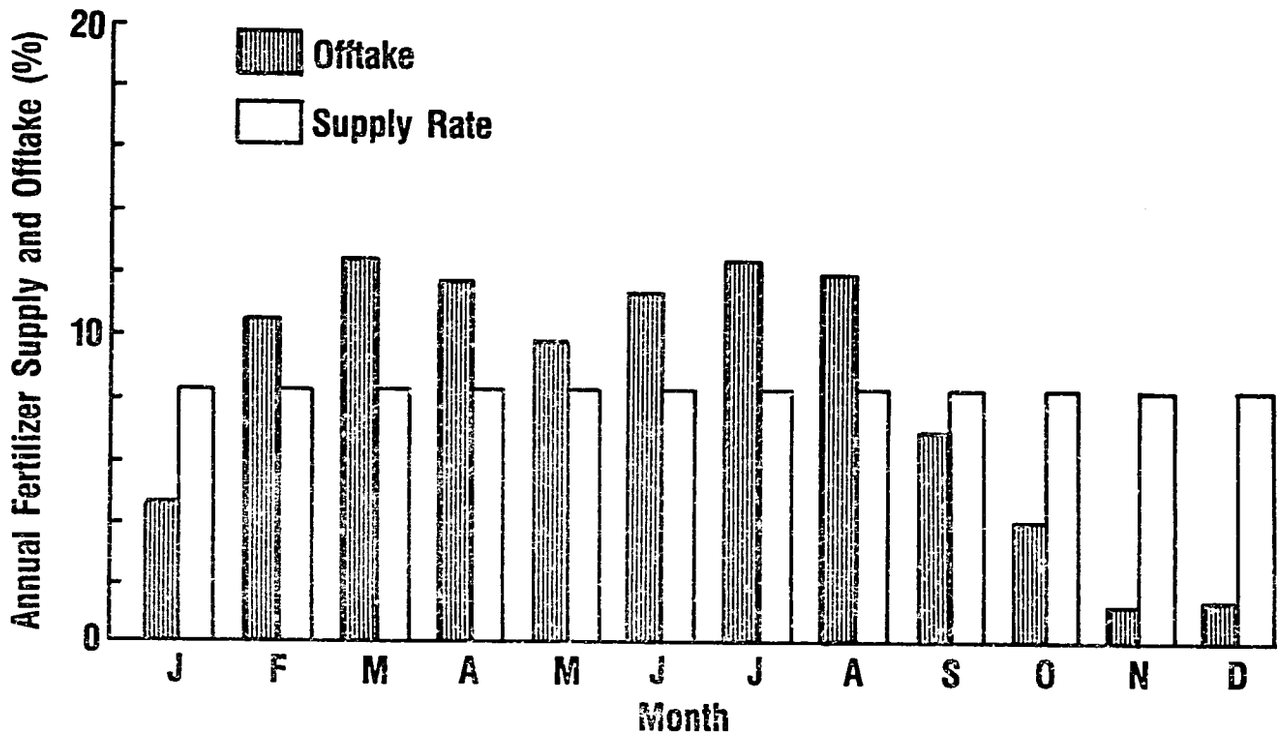


Figure II-12. The National Supply and Offtake Pattern by Months.

Shipping plans should generally be based upon a time of arrival in Douala of at least 2 months prior to the time of application. The amount of annual rainfall and its distribution by month varies generally from north to south. In the tropical rainforest area of the southern portion of Cameroon, the season of rainfall is heavy and prolonged as shown in the introduction section. In the northern provinces, the dry periods are longer and the rains arrive later in the year. Appendix J shows the usual rainfall patterns. In addition, a second set of diagrams gives the consultants' estimate of the most favorable fertilizer application schedule in each province. These schedules are based on the planting dates and the climatic pattern.

The onset of the rainy season in each province should determine when fertilizer stocks should be in place at the local sales points. An application of basal or starter fertilizer is needed at planting time and a sidedressing at a later period. The surface of the roads may deteriorate following the onslaught of the heavy rains and prevent later deliveries. The required stocks must be carefully planned. An approximate priority order for fertilizer deliveries to provinces is indicated in Table II-17.

The seasonality of ideal offtake in each province should be estimated. An example of the overall national seasonality of offtake is shown in Table II-18. In the Extreme North, 70% of the fertilizers are used in 3 months, whereas in the North West fertilizers are used throughout the year.

The overall offtake should be approximately equal during the months of February, March, April, May, June, July, and August. This would leave 5 months of the year to build stocks at primary distribution centers as shown in Figure II-12.

An example of a national stockage level is illustrated in Figure II-13.

Infrastructure and Additional Government Policy Required to Support the Recommended Fertilizer Marketing System

Evaluation of the Road Network

The Cameroon road system is classified into National Routes, Provincial Routes, and Departmental Routes. This road network is shown in Figure II-14. All of the fertilizer primary distribution centers are accessible using the main road network. Not all roads are new or of a high standard of construction, and the Ministry of Equipment has a continuous program for road rehabilitation. The rate of road improvement in each category is shown in Table II-19. The spectrum

Table II-17. Approximate Priority of the Delivery of Fertilizer to the Provinces (Based Upon the Onset of the Rainy Season)

Sequence Number	Province
1	Littoral
2	South West
3	South
4	West
5	North West
6	Central
7	East
8	Adamaoua
9	North
10	Extreme North

Source: Rainfall data and consultants' estimates.

Table II-18. Overall Seasonality of Offtake

Province	Weighted Percentage of Annual Total in Month[a]												Quantity Weighting of Province
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Adamaoua	0.003	0.005	0.007	0.018	0.014	0.01	0.016	0.012	0.008	0.003	0.002	0.002	0.1
Central	0.018	0.036	0.054	0.114	0.048	0.036	0.06	0.102	0.072	0.003	0.018	0.012	0.6
East	0.038	0.152	0.247	0.304	0.152	0.133	0.266	0.228	0.209	0.076	0.057	0.038	1.9
Extreme North	0	0	0.348	0.58	2.78	4.18	2.32	1.16	0.232	0	0	0	11.6
Littoral	1.53	3.37	5.20	4.28	2.45	2.14	3.37	3.98	2.14	1.53	0.306	0.306	30.6
North	0	0	0.686	1.86	2.06	2.25	1.37	0.882	0.686	0	0	0	9.8
North West	0.693	1.68	1.19	0.792	0.693	0.792	1.29	0.99	0.594	0.495	0.396	0.297	9.9
South	0.025	0.04	0.07	0.08	0.04	0.035	0.045	0.065	0.04	0.035	0.015	0.01	0.5
South West	0.424	1.06	1.80	1.59	0.74	0.53	1.17	1.48	0.954	0.424	0.212	0.212	10.6
West	1.95	3.90	2.93	2.20	0.976	0.976	2.68	3.17	2.20	1.71	0.488	0.732	24.4
Overall seasonality (%)	4.68	10.57	12.5	11.8	9.95	11.4	12.6	12.1	7.14	4.28	1.49	1.61	

a. Based on an average of 1984 and 1985 distribution.

Source: Ministry of Agriculture Cropping Patterns and Consultants' Estimate of Delivery Schedules.

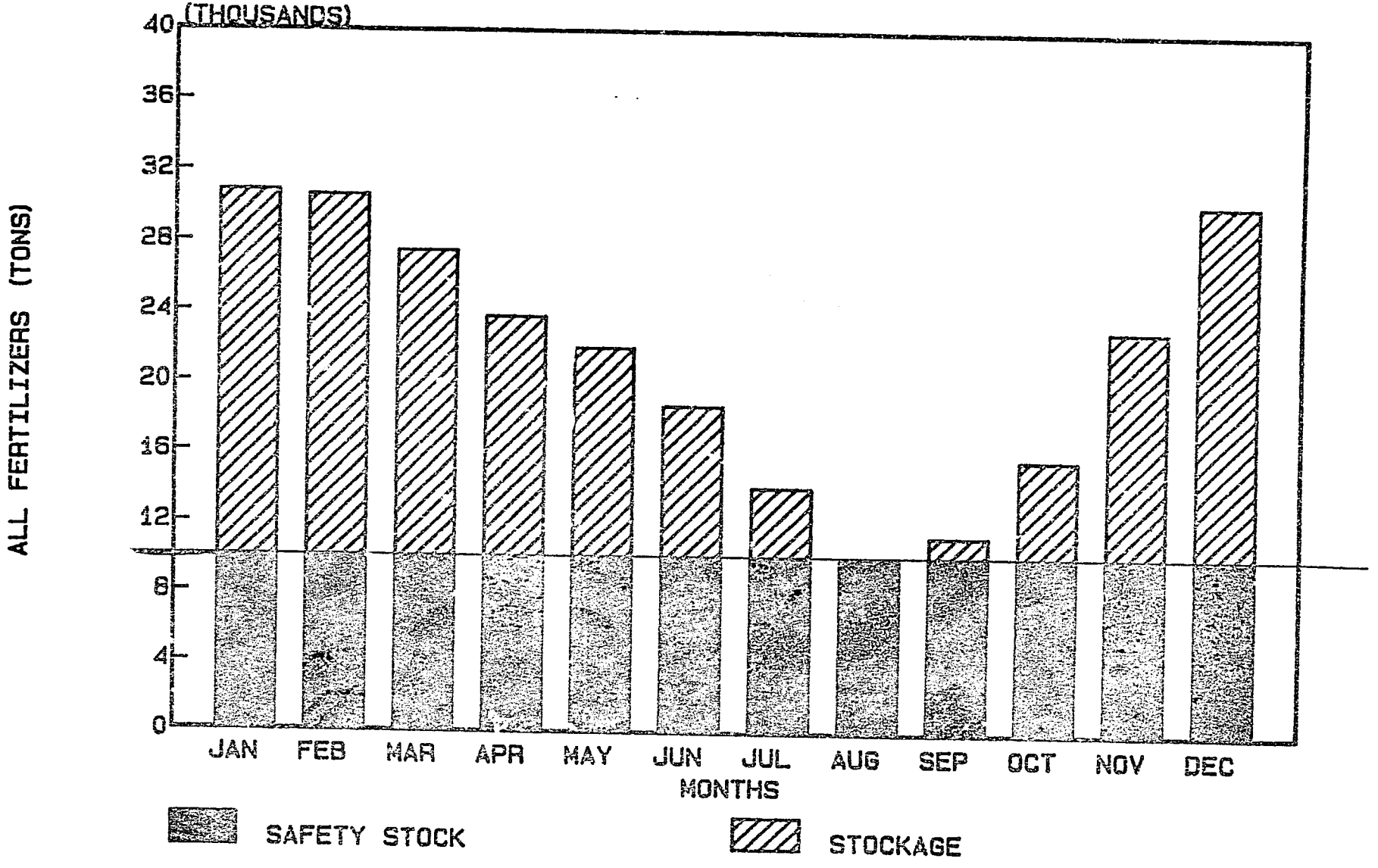


Figure II-13. A Typical National Stockage Level for All Fertilizers in Cameroon.

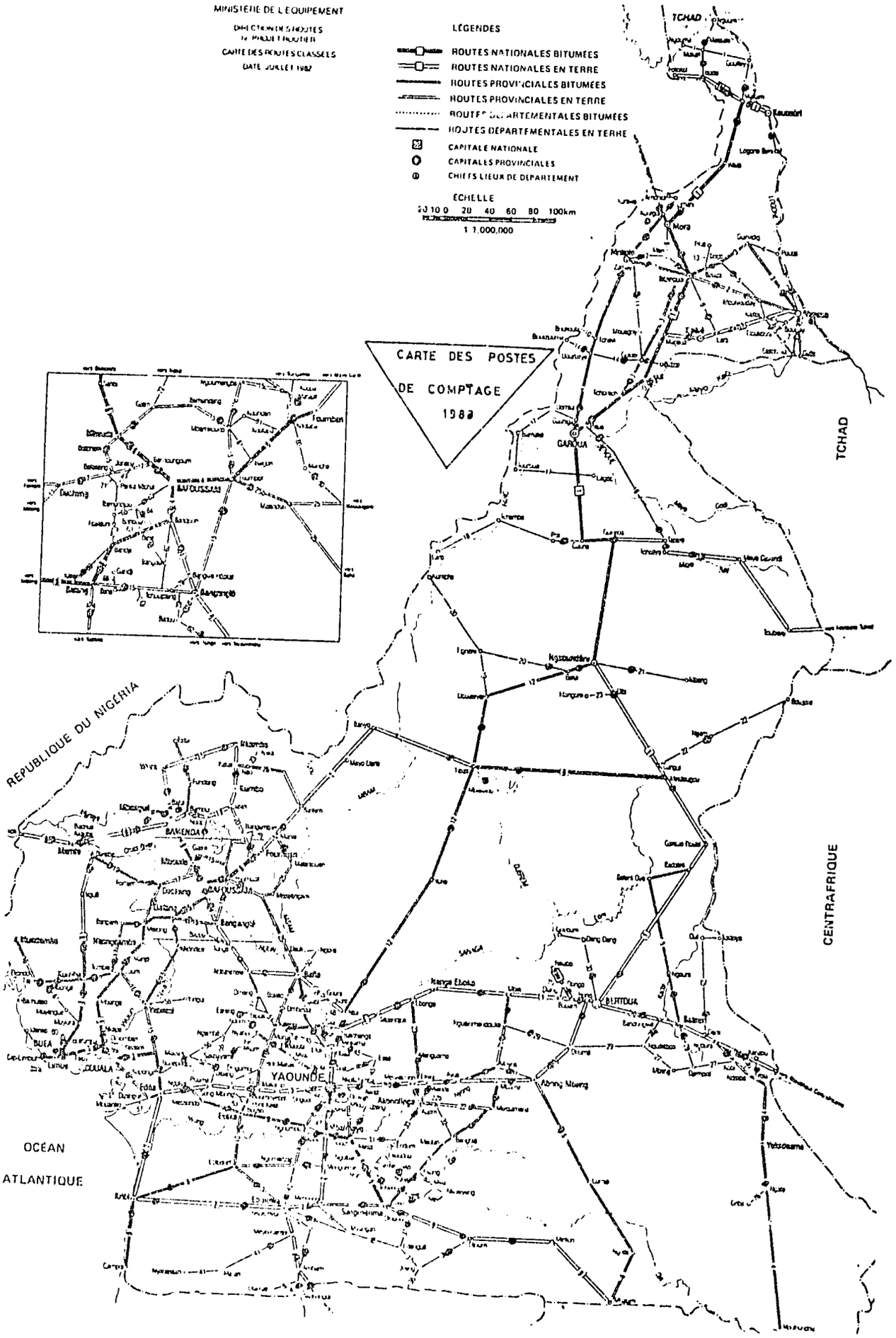


Figure II-14. The Road Network in Cameroon.

Table II-19. Evolution of the Road Network (km) in Cameroon 1972-84

Catégorie de Routes	1972	1974	1976	1978	1980/81	1981/82	1982/83	1983/84	1984/85
I. Routes bitumées	1,417	1,610	1,977	2,271	2,495	2,506	2.522	2,782	2,912
Routes en terre									
Nationales	996	1,195	1,021	2,002	4,184	4,184	4,195	4,222	5,100
Provinciales	2,339	2,468	2,822	3,915	6,069	6,069	6,129	6,133	5,561
Départementales	2,152	3,064	5,716	6,312	6,064	6,041	-	6,002	7,913
Rurales	6,034	6,196	5,526	4,171	13,913	13,913	13,923	15,428	12,409
Class E	7,959	9,315	9,240	10,004	-	-	-	-	-
Total du réseau classé	20,947	23,848	26,302	28,675	32,725	32,714	32,781	34,567	33,905
II. Pistes Non Classées (estimation)	22,000	25,000	28,000	30,000	31,000	31,000	31,000	31,000	31,000
TOTAL GENERAL	42,947	48,848	54,302	58,675	63,725	63,714	63,781	65,567	64,905

Sources: 1. 1972-78: Banque Mondiale--Rapport 2225-CM-Rapport d'évaluation du IVe Projet Routier.
2. 1980/81-1984/85: MINEQ Budget d'entretien routier.
3. Des vérifications sur les kilométrages expliquent les baisses constatées sur la longueur du réseau.

of road conditions therefore changes continuously. Although there are isolated lengths of road that are in poor condition, especially during the periods of high rainfall, one of the main problem areas is the main road between Foumban and Ngaoundere. This untarred road segment is useful for the movement of fertilizer to the North and Extreme North Provinces only during dry periods.

The surface condition of the roads as of July 1982 is given in Table II-20. In order to increase the length of road that could be tarred with available funds, it has been necessary to design the main roads fairly lightly. Most of them have design lives of about 7 years. This suggests that the country will face considerable investment in maintenance, overlays, and rehabilitation. However, this is not a problem confined specifically to fertilizer traffic.

The condition and extent of the farm-to-market (rural) roads limits the establishment of primary distribution centers within short distances of the farms (Table II-20). The percentage of rural roads varies widely between provinces, i.e., West 51%, North 16.5% (Figure II-15). The kilometers of each type of road as of July 1984 is shown for each political subdivision in Appendix K, Table 1. Of the total 2,922 km of tarred roads in Cameroon, 34.8% occur in two provinces, Extreme North and North. Only 8.6% of the road network is tarred.

Essentially all vehicles used to transport goods carry payload in excess of their rated capacity. Officially this is 10 tons per axle.

The Government of Cameroon has initiated a program of weighbridge installation to combat this abuse, but as yet none are available for use. The road damage situation is exacerbated by the fact that almost all articulated vehicles used for transport of heavy goods in Cameroon are 4-axle (2-axle tractor unit and 2-axle trailers, or 14-wheeler), rather than 5-axle (3-axle tractor unit and 2-axle trailers, or 18 wheeler). A comparison of these two types of vehicles is shown in Appendix K, Table 2. The damaging effect of the 4-axle vehicle is considerably more than that of the 5-axle vehicle, particularly at higher payloads.

Considering only the road transport costs, it is, of course, cheaper to transport fertilizer in the largest possible loads of 30-35 mt. But if associated costs to the national economy in terms of road damage are included, there is no doubt that the loads should be restricted. Resolution of the problem of vehicle overloading is a national issue. The consultants suggest that two immediate steps be taken:

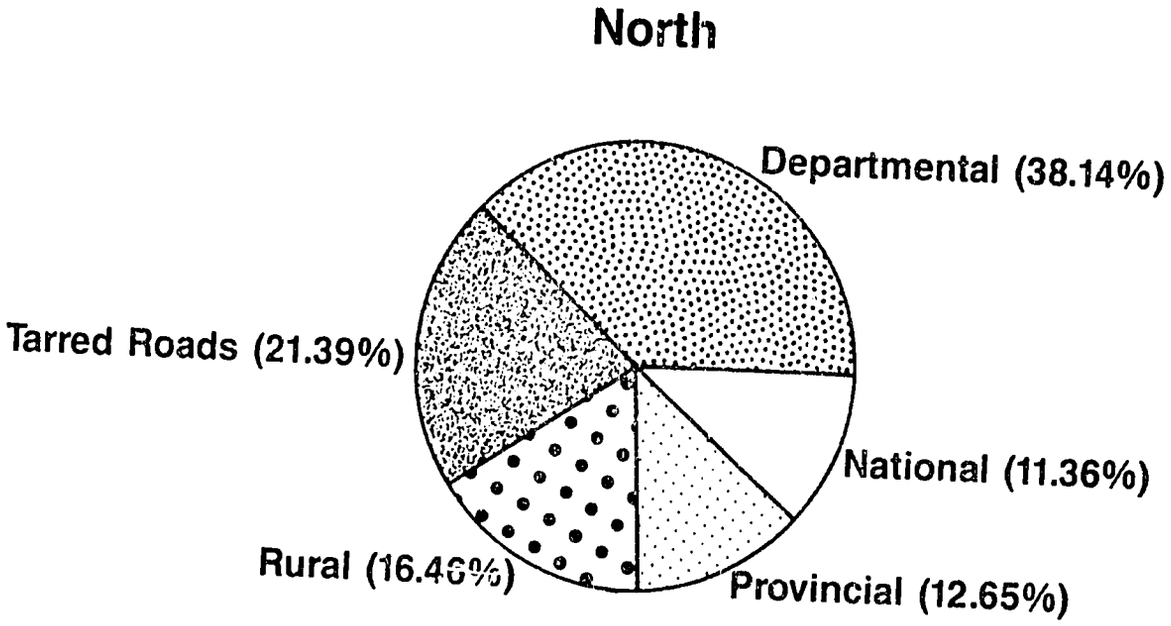
1. Restrict all truck loads to a maximum of 35 mt, whatever the claims made by the hauler.

Table II-20. The Cameroon Road System (km) in 1984/85

Province	Tarred Roads	Soil Surfaced Roads				
		National	Provincial	Departmental	Rural	Total
Extreme North	406	267	721	935	1,210	3,539
North	612	325	362	1,091	471	2,811
Adamaoua	320	709	276	563	361	2,218
South	83	1,053	378	1,186	948	3,648
Central	396	916	1,100	1,854	2,161	5,827
East	34	810	1,161	1,040	1,100	4,154
West	232	144	692	647	1,787	3,502
Littoral	366	104	471	452	952	2,345
South West	395	313	145	486	1,471	2,740
North West	68	459	256	370	1,968	3,121
TOTAL	2,912[a]	5,100	5,561	7,913	12,409	33,905

a. 2,141 km of national roads, 280 km of provincial roads, 11 km of departmental roads, 26 km rural roads, and 363 km of city streets.

Source: Ministry of Equipment, Department of Highway, 1984.



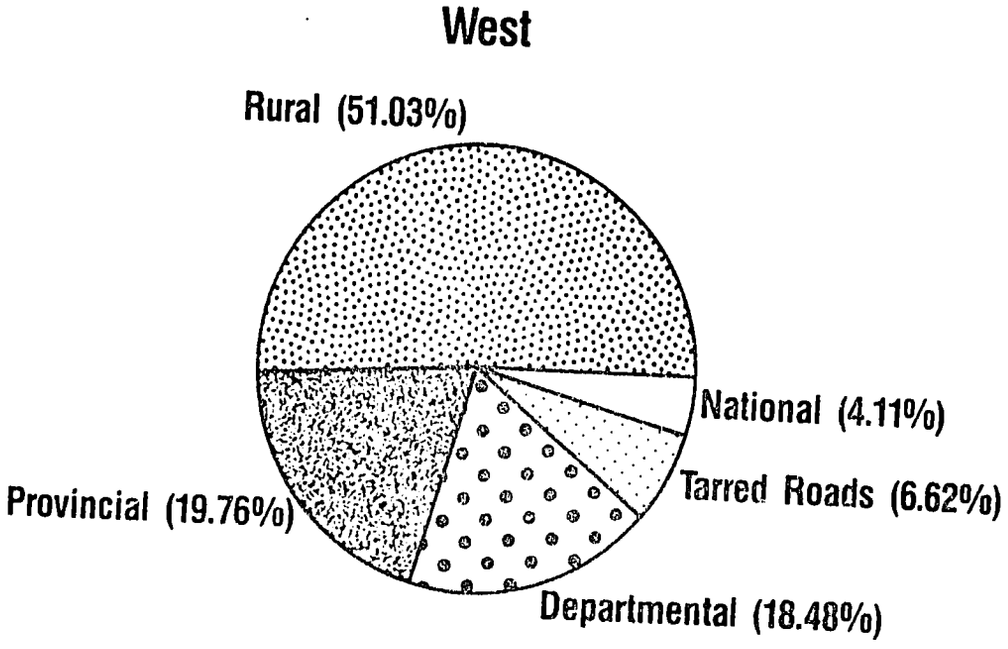


Figure II-15. Composition of the Road System in North and West Provinces.

2. Give automatic loading priority to 5-axle vehicles whenever these are available.

In view of the problems of overloading, it seems likely that the Cameroon road system may exhibit increasingly rapid damage and deterioration unless road regulations are enforced.

The extension of the road network and the general improvement of the national routes are being studied by the Ministry of Transport. The consultants assume that special emphasis will be placed on the rural farm-to-market roads. A prerequisite to agricultural development generally is the development of these rural roads. For example, for every metric ton of fertilizer moving into a community, 8-10 mt of crop produce should move out to markets. If farm-to-market roads are not developed, fertilizer marketing will be limited and expensive, and therefore food-crop production will be deterred.

Availability of Other Essential Crop Production Inputs

1. In traditional African agriculture, labor is one of the most expensive inputs. According to an IITA and Ministry of Agriculture survey of 216 farmers by Atayi and Knipscheer in 1980, in Cameroon about 50% of the labor force comes from work groups, 31% from family labor, 15.3% from hired labor, and 4.7% from paid friends. About 52% of the labor is used for land clearing, 24% for planting, 18% for seed bed preparation, 10% for weeding, and 2% for harvesting. At least 50% of the farmers belong to at least one work group. The payment for the work group consists of food during the work period. About 265 workdays/ha are required for the production of food crops. Of this, 180 workdays are provided by work groups.

   There is evidence of some migration to the urban areas. The economically active population in Cameroon agriculture remains at 79% as compared with 63% for all of Africa according to FAO data. Although there may be local shortages, there appears to be adequate agricultural labor for hire.
2. Insecticides are 100% subsidized by the central government. In 1984, Cameroon imported pesticides valued at US $22 million. Even so, only the export crops appear to receive pesticide treatment. These crops are treated because adequate technical supervision is provided for the production of the crops. The study team did not find pesticides being specifically channeled toward the production of food crops. The recommendations for their proper use were not being transferred to farmers. In the survey by Atayi and Knipscheer, only 3.7% reported using insecticides on food crops.

Use is limited by short supply and lack of knowledge concerning their use. The use of herbicides was observed.

3. Farmers spend very little on capital inputs for the production of food crops. The Atayi and Knipscheer survey indicates that 73% of the farmers spend less than FCFA 3,000 on farm tools. Most of their tools are locally made. The most popular tools are cutlasses and hoes, and they are generally available. There is a need for labor-saving simple tools that are suitable for small farm operations, i.e., solar-operated sprayers and injector planters.

4. Except for groundnuts, the majority of farmers obtain their food-crop seeds from previous harvests. For example, 75% of the farmers do not buy maize seed, 47% do not buy groundnut seed, 99% do not buy rice seed. Of those that do buy, most of the seeds are purchased from friends and neighbors. Only 2% of those farmers that do purchase seed do so in the local market.

   There is a seed multiplication program in the North for cereals and cowpeas. This program is just getting underway and is urgently needed for improved crop varieties. New high-yielding varieties of maize and rice are being developed on a limited scale, but there is no marketing system to make them available to small farmers. MIDEVIV has a program for the production and marketing of food crops. Food crop markets are urgently needed in most farming areas in Cameroon. Food crop markets in agricultural expansion areas are needed to give farmers a place to market their produce.

5. Most of the production credit available is associated with loans for the production of export crops. Most of the operational credit is advanced in kind rather than as cash. It is recoverd through the purchase of the crop produce. The South West Cooperative and UCCAO extended limited credit on fertilizer purchases to their members. However, a FONADER study showed that 50% of the credit extended for fertilizer purchases was not recovered. The recommended fertilizer marketing system in the North West Province will utilize credit that is provided by FONADER in five different ways:

   a. To selected smallholder customers through a FONADER credit officer.
   b. To members of the North West Cooperative through the cooperative.
   c. To cooperatives as extended low-cost loans for operations..
   d. To individual farmers who pay for 20% of the inputs in advance.
   e. To credit unions.

   Institutional credit for the purchase of fertilizers and other essential inputs for food-crop production on a national basis has not been fully

developed. Farmers use practically no credit for the production of food crops. The Atayi and Knipscheer survey in the East Province revealed that only about 10% of the farmers had ever used credit. The majority of credit users obtained credit from their friends. Credit was mostly used to pay school fees and for funerals and health care.

The study team found that the lack of purchasing power, including credit means, limits the optimum use of essential inputs.

Availability of Structured Markets Where Farmers Can Sell Their Crop Products

In Cameroon, prices are set by the government for several major crops, including cocoa, coffee, rice, and cotton. Cocoa and coffee prices are controlled in Cameroon by the ONCPB. This agency historically has set prices at a level where farmers receive about half of the actual world market prices (see Tables I-31, I-38, and I-43 for Arabica coffee, Robusta coffee, and cocoa, respectively). The government then earns foreign exchange at the expense of the farmer. This is no different from a 50% tax on agricultural production. It strongly reduces the incentive to maximize agricultural production through the use of modern inputs.

Some food-crop prices, such as those for maize, are set by market forces. Although this is seen as more fair to the farmers, adequate markets do not exist. Prices are significantly higher before harvest, and then prices at harvest are very low. This reflects a lack of storage facilities for the farmer and the fact that because of financial pressures many farmers must sell their crops as soon as they are harvested. Prices in different parts of the country are quite different (Table II-21). This reflects supply and demand conditions, but these are influenced greatly by lack of adequate roads and lack of market information and alternative marketing opportunities for the farmers. If the government expects to increase food-crop production, then it must ensure that adequate markets are available to purchase the farmers' production at a price that is profitable to the farmer.

Formal Training and Personnel Development Required to Manage a Fertilizer Marketing System

The formal training for fertilizer marketing managers should include a program to meet the following objectives:

1. To understand the nature, functions, and operations of the fertilizer sector as an essential part of the Cameroon national food production requirements.

Table II-21. Prices of Food Crops in Various Provinces 1984 (FCFA/kg)

Province	Maize	Sorghum	Rice	Yams	Groundnuts
Extreme North	130	126	79	0	189
North	107	118	117	0	188
Adamaoua	79	80	0	0	175
East	119	0	0	0	214
Central	118	0	0	108	253
South	143	0	0	0	266
Littoral	119	0	0	120	180
South West	87	0	0	70	138
North West	93	34	80	49	139
West	62	0	0	69	170
Cameroon	89	96	80	86	193

Source: 1984 Census of Agriculture.

2. To learn the soil fertility and plant nutrient systems appropriate to the agriculture of Cameroon.
3. To acquaint the managers with various fertilizer materials.
4. To familiarize the managers with chemical and physical methods used in the manufacturing of fertilizers.
5. To understand the importance and methods used in achieving control of fertilizer quality.
6. To develop concepts and skills used in the marketing of fertilizers, including:
   a. Accounting.
   b. Finance.
   c. Economics.
   d. Personnel Development.
   e. General Administration.
   f. Logistics.
   g. Promotion.
   h. Market Research.
7. To develop management skills to include systems for planning, organizing, implementing, and evaluating a fertilizer marketing system.

Those individuals selected to manage the future Cameroon fertilizer sector should receive formal training in the above subject matter. Special funding for the students at an appropriate instructional institution must be provided.

Informal training for marketing startup that is required for personnel development occurs in five steps. Much of this training is a one-on-one type and occurs over an extended time period.

1. Management at company headquarters is trained by direct association with experienced individuals in the respective fields of endeavor.
2. These trained managers serve as instructors in a 6-week basic training course for new employees as they join the firm.
3. The field managers trained in the basic marketing course select and establish the retailer organization and provide in-service training over all five phases of the marketing startup. They provide support to the retailer in farmer educational programs.
4. Retailer development is a key to a successful fertilizer marketing organization. The retailer training will include management of retail operations, soils and crop production, nature and functions of fertilizers, financial management and promotion techniques. The retailer is the key

connecting link to the farmer. The retailer, supported by the technical component of the fertilizer marketing company, serves as the chief source of fertilizer information to his farmer customers.

5. The company's entire promotion program focuses on improving the knowledge of their farmer customers.

The efficient use of fertilizers is directly dependent upon the knowledge that farmers have concerning their use as well as other crop husbandry practices. Demonstrations of "packages of practices" through farmer meetings, field days, crop production contest, etc., show the difference between existing and improved practices.

Advanced Individual Training--The second phase of training occurs when new products and technology are to be introduced, when field staff have sufficient experience to merit additional professional development, and when the managers are preparing their second annual plan for supply and marketing. Some individuals will need additional formal training prior to their promotion, which the company cannot provide.

As the company is formed it will be necessary to identify needs and develop training courses to meet specific conditions. IFDC is especially qualified to assist with developing appropriate training courses for fertilizer supply and marketing. Training should include such subjects as the following:

1. Compensation and performance appraisal.
2. Effective communications.
3. Accounting procedures.
4. Improved promotion techniques.
5. Professional selling.
6. Territory management.

The company will employ the basic personnel development concept that all employees will be trained to achieve their fullest potential. The company will provide the best of training so that its employees are the best qualified individuals in the marketplace. Incentive programs for performance will be an integral part of the employee relations program. Because of the anticipated rapid turnover of qualified personnel, the company will provide training for two individuals for each authorized position.

Additional Infrastructure and Government Policy and Actions Required to Support an Effective Fertilizer Marketing System

Policies with respect to fertilizer research, organization, ownership, distribution, sales, promotion, prices, production, and crop produce markets have been discussed in the preceding section. The additional fertilizer-related policy and actions identified by the study team include taxation, credit, quality control, land use development, and education in agricultural technologies.

Taxation--Taxation on agricultural products in Cameroon to a large degree is hidden from the farmer. As discussed earlier, farmers receive roughly one-half the world market price for coffee and cotton. This is the same as a tax on produce. This results in a disincentive for the farmer to produce.

Fertilizer import duties in the form of licenses, tender charges, vehicle licenses, fuel taxes, etc., impose higher fertilizer prices at the retail level. Higher prices will thus generate a need for more fertilizer subsidies in order to keep fertilizer prices low. It is in the national interest that the company be given a pioneer industry status and be exempted from profit taxes during its first 5 years of operation. The same is true for import duties on fertilizer materials and sales tax on fertilizer materials, soil amendments, and finished fertilizers.

Credit--Credit for the purchase of fertilizers and other essential crop production inputs is necessary to achieve the sales of fertilizer forecasted by the new marketing system. In the future as much as 25% of the fertilizer sold for use on food crops may require some form of credit plan. There is a need for a national agricultural production credit bank that can formulate loan policies based on sound lending principles. There are needs for various terms of credit--short, intermediate, and long term. Individuals or organizations offering credit need to recognize the seasonal needs and income characteristics of agriculture and appraise the soundness of loans. Poorly supervised credit is harmful in the long run to the farmer and the individual or institution doing the lending, and it may be harmful even to the overall growth of agriculture in the country. The study team suggests that making sound credit available is really more important than holding interest rates very low or inducing subsidies through credit. Most credit studies concerning small farmers suggest that the important ingredients for success include (1) a fiduciary relationship between farmers and the institution providing the credit; (2) providing instructions on how to use credit effectively; (3) eliminating elaborate forms and procedures;

(4) making credit available at convenient locations; and (5) providing firm but flexible conditions for repayment. When a new countrywide credit program is established, every effort should be made to (1) simplify credit terms; (2) make the credit available; (3) place both the lenders and collection personnel in one organization; (4) issue credit in terms of kind, but give the farmer options of purchasing from several holders; and (5) maintain market rate of interest on credit. This, hopefully, will help the small farmers who quite often cannot get institutional credit and finally must risk paying exorbitant interest to lenders. The higher interest would also discourage large farmers from misusing credit facilities.

A program for intermediate and long-term credit should be developed. This would be for capital improvement for the agricultural base, labor-saving equipment, produce storage facilities, transport equipment, land clearing, soil conservation, and irrigation. Business principles for the production credit as cited above apply to longer term credit. This program should not be an inexpensive source of capital for large farmers or retailers but should be directed to the small farmers.

Quality Control--Quality control will be required for a future high-volume fertilizer industry in Cameroon. Some Ministry of Agriculture organization that has personnel operating in the field and has comprehension of fertilizer technology should be given the responsibility for formulating the policy. After the government institutes a quality control law, this organization should implement a field program to ensure that fertilizers meet the conditions. A prototype quality control law is given in Appendix L. The quality control legislation should cover several important areas:

1. The analysis of each fertilizer should be stipulated on the bag and invoice. Examples of the analysis could be 10-30-10, 20-10-10, 46-0-0, etc. Regulations should cover the size and location of the analysis labeling on the bag.
2. The analysis of the fertilizer must meet the analysis stipulated on the bag and invoice within tolerances. If a bag stipulates a 10-30-10 analysis, this should be what the farmer receives.
3. The nutrient forms and sources should be stipulated on the bag. For example, nitrogen sources could include ammoniacal nitrogen from ammonium sulfate or ammonium phosphate; nitrate nitrogen could be from ammonium nitrate or calcium ammonium nitrate; phosphates could be from water-soluble sources or

citrate-soluble sources; potassium could be from potassium chloride or potassium sulfate sources; sulfur could be from elemental or sulfate sources. Sources of nutrients are important in soil chemical reactions, storage, and spreading qualities and crop yields.

4. Physical properties as stipulated to the supply sources to meet market conditions must be identified in the quality control legislature. Inspection should be made in the field to ensure that specifications have been met.
5. Package net weights must be indicated on the bags.
6. The manufacturer of the fertilizer should be stipulated on the bag.

Land Use Development--Land use development for future agriculture production in Cameroon is needed. Because of its geographic location, favorable soils and climatic conditions, and level of agricultural technology, Cameroon can expand its role as a source of food crops in central and western Africa by enacting legislation to encourage agricultural development. Such policies would encourage the following:

1. Opening of new lands for food-crop production by title grants, road construction, low-cost loans for private construction, etc.
2. Development of new agribusiness enterprises in the food-crop sector. For example, policy to grant tax holidays to vegetable processing firms to establish processing facilities in the appropriate ecological zones.
3. Establishment of a national soil and water conservation service to improve the use of their natural resources by preventing soil erosion and ensuring the replenishment of suitable mineral reserves.
4. Development of irrigation facilities in appropriate areas to ensure a supply of water for crop production. Project development should include regulations on utilization of water resources.

Education--Education in agricultural sciences to sustain and increase agricultural production is an important policy issue that should be considered. There appear to be too few quality facilities for agricultural education in Cameroon. Agricultural curricula that will teach the students agricultural technologies required to farm, process crop produce, market crop produce, and manage an agribusiness are needed.

More adult training centers should be developed. A key function of the centers would be to familiarize adult farmers with improved practices

required to increase crop production and decrease cost. The centers should include adult farm women since they play an important role in producing and marketing crops.

SECTION III
TECHNICAL AND ECONOMIC EVALUATION OF FERTILIZER SUPPLY SCHEMES

Any fertilizer marketing system, including the recommended system described in Section II, must have a reliable source of appropriate fertilizers to enable the system to function efficiently. The classic approaches used to supply fertilizer to a marketing system are (1) importation of finished products, (2) domestic production based on imported and/or locally available raw materials, or (3) a combination of imported finished products and domestic production.

At present, Cameroon relies exclusively upon importation of finished products to supply its needs. For a brief period (1976-82) the SOCAME plant at Bonaberi produced granular fertilizer based exclusively upon imported raw materials. This operation was uneconomic, and production was discontinued.

This study evaluates the technical and economic feasibility of all major fertilizer supply alternatives that may be applicable to the Cameroon situation, including the salvage of the SOCAME plant. The SOCAME plant site and warehouses (with some modification and repair) are well suited for the proposed fertilizer bagging/blending/storage alternatives listed below. However, rehabilitation of the SOCAME granulation unit is not feasible because the equipment has deteriorated to the point that it is beyond repair. The alternatives with the major justifications for study are listed.

Fertilizer Supply Alternative	Major Justification for Study
1. Domestic production of urea and DAP based on locally available natural gas feedstock and imported phosphoric acid. Plant capacity for supplying only domestic demand.	Natural gas feedstock (available in Cameroon) usually represents about 70% of the variable cost of urea production; need for a high-phosphate fertilizer (DAP) as identified in the previous sections; small plant would be more compatible with Cameroon's technical resources; small plant would require less investment than would large world-scale plant.
2. World-scale urea and small DAP plant based on locally available natural gas feedstock and imported phosphoric acid.	Exploitation of Cameroon's natural gas reserves by exporting urea on the world market; supply Cameroon's needs for urea and a high-phosphate fertilizer (DAP) as previously identified.

(Continued)

Fertilizer Supply Alternative	Major Justification for Study
3. Importation of finished products (bagged).	Current practice; low investment; flexible; often most practical alternative if tonnage is less than about 100,000 mtpy.
4. Importation of finished products in bulk with local bagging.	Low investment; flexible; usually less expensive than shipment in bags; potential for savings in foreign exchange.
5. Bulk blending of compound fertilizers using imported raw materials.	Process/product flexibility for maximum responsiveness to changes in the market; relatively low investment; savings in foreign exchange due to bulk imports and local mixing and bagging.

It should be pointed out at the outset that conclusions and recommendations concerning the above supply alternatives were incorporated in the proposed recommended fertilizer marketing system (RFMS). Based on a benefit/cost analysis, construction of a fertilizer bagging plant is envisioned during Phases I and II of the implementation of the RFMS. The completed bagging plant will process about 25,000 mt of fertilizer (equivalent to about 50% of fertilizer imported and distributed through the RFMS) during Phase II of the RFMS. The need for a bulk-blending plant will be determined during Phases III-V of the RFMS concurrent with the importation and bagging of bulk fertilizers. If bulk-blended fertilizers are successfully introduced, the bulk-blending plant will, by Phase V, process a significant portion of the 110,000 mt of fertilizer imported through the RFMS.

The option to exploit Cameroon's natural gas reserves and produce urea and DAP locally is treated separately from the RFMS because of the importance of the large investment involved.

A discussion and analysis of the technical and economic components of these fertilizer supply alternatives follow.

Ammonia/Urea/DAP Complex

The preliminary feasibility of the small and large ammonia/urea/DAP production complexes was examined. The complexes would consist of three basic process plants--(1) ammonia, (2) urea, and (3) DAP. Other auxiliary and support facilities would also be needed. All ammonia output would be used to produce urea and DAP. The two raw materials required for the complexes are local natural

gas and imported phosphoric acid. A discussion of the process technology, raw material supply, plant capacity, plant location, and production economics follows.

Ammonia Process Technology

The process principles for the production of ammonia are the same for the small (200-mtpd) and large (1,000-mtpd) plants although there are some variations in the detailed plant design. The following process description applies to both size plants unless noted otherwise.

A typical flow diagram for the production of ammonia from natural gas by the steam reforming process is shown in Figure III-1. Natural gas, the major raw material, contains mainly methane (CH_4) and lesser amounts of impurities such as nitrogen, argon, carbon dioxide, and hydrogen sulfide.

Ammonia is prepared (synthesized) from natural gas (methane), water, and air according to a series of reactions described later. In the overall process, two-thirds of the hydrogen for the synthesis of ammonia is obtained from natural gas and one-third is obtained by decomposing water. Approximately 8.6 million kcal (about 35 million Btu or 1,100 m^3) of natural gas is required to produce 1 mt of ammonia. A large portion (about 35%) of this amount of natural gas is used as fuel to provide heat to promote conversion of the raw and intermediate materials into ammonia. Most of this heat (energy) is recovered to produce process steam and/or electricity for operation of the complex. One major difference in the design of small- and large-scale ammonia plants is the efficiency in the recovery of the waste heat. In general, because of improved efficiency in larger plants, the natural gas requirement for the large-scale ammonia plant is 5%-10% less than that for a small-scale ammonia plant.

The ammonia process consists of eight basic steps:

1. Desulfurization of the natural gas feedstock.
2. Primary reforming.
3. Secondary reforming.
4. Conversion of carbon monoxide to carbon dioxide (shift conversion).
5. Carbon dioxide removal.
6. Methanation.
7. Compression.
8. Ammonia synthesis.

A brief description of each process step follows.

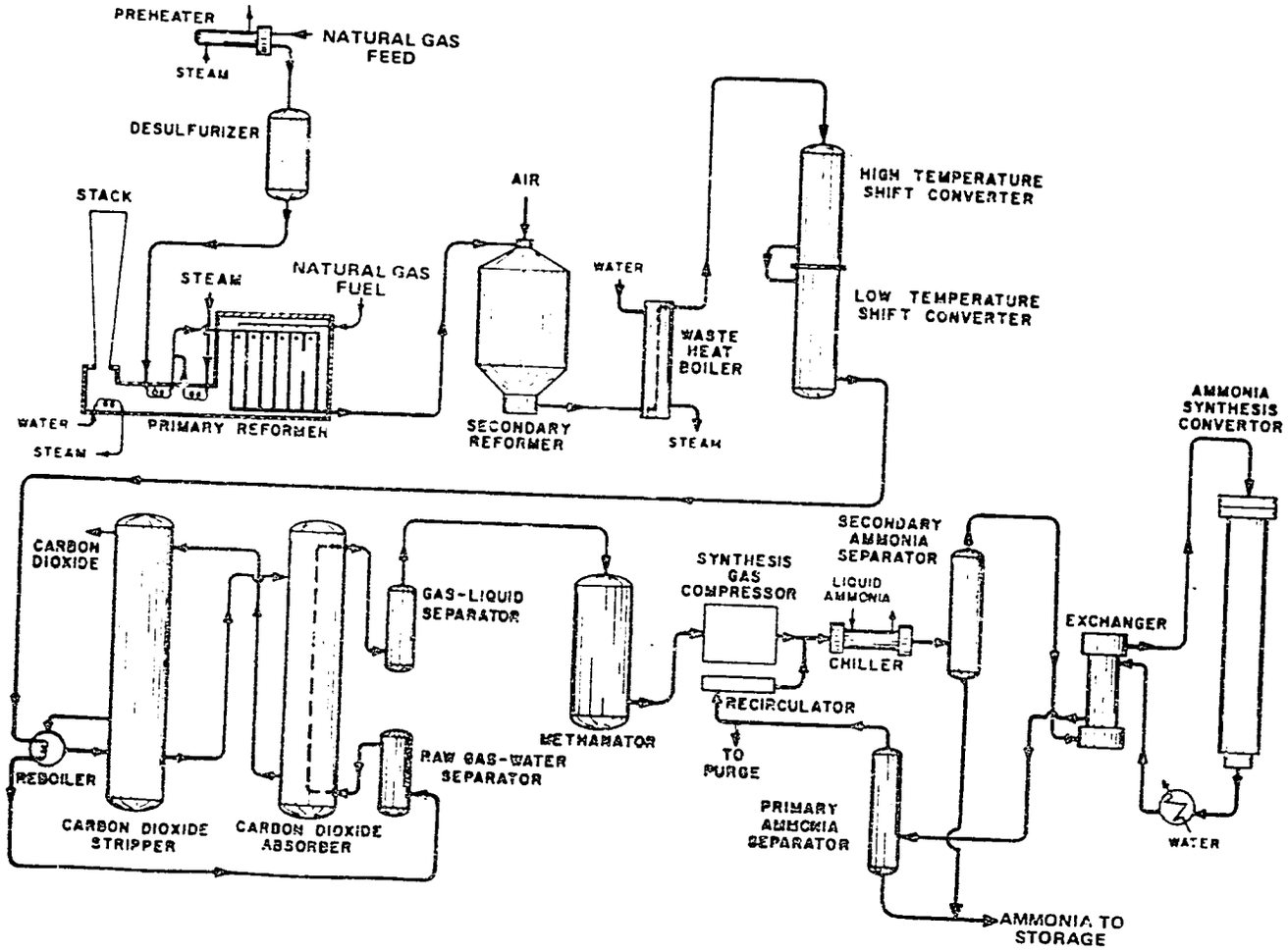


Figure III-1. Typical Flow Diagram—Ammonia Process.

Desulfurization of Natural Gas Feedstock--Since the sulfur compounds present in the natural gas are harmful to the reforming and carbon monoxide (CO) conversion catalysts, it is essential to remove these compounds from the natural gas feedstock. To remove these unwanted compounds, the natural gas is preheated to 290°-400°C and is passed through a bed of zinc or iron oxide. The zinc or iron oxide containing the accumulated (absorbed) sulfur compounds is periodically removed and replaced with fresh (regenerated) material.

Primary Reforming--The desulfurized natural gas is mixed with superheated steam and then heated by the flue gas from the primary reformer. The steam-natural gas mixture is then introduced into the primary reformer where the temperature is sufficiently elevated (800°-900°C) so that the natural gas reacts with the steam in the presence of a catalyst to form carbon oxides and hydrogen according to the following reactions.

$$CH_4 + H_2O \rightarrow CO + 3H_2$$
$$CO + H_2O \rightarrow CO_2 + H_2$$

The heat required for these endothermic reactions is supplied by heating the reformer with natural gas fuel. The process gas leaving the primary reformer usually contains 5%-15% methane (dry basis).

Secondary Reforming--The process gas from the primary reformer flows to the secondary reformer. Compressed and heated air is also introduced into the secondary reformer. In the presence of a catalyst, the oxygen contained in the process air reacts exothermically with the unreformed process gas (mostly CH_4) to form carbon dioxide and hydrogen according to the following reaction:

$$CH_4 + O_2 \rightarrow CO_2 + 2H_2$$

The nitrogen contained in the process air provides the nitrogen value needed in the synthesis gas. The process air is fed to the secondary reformer at a predetermined rate to give the proper hydrogen/nitrogen ratio in the final synthesis gas. As the reacting mixture flows through the bed of catalyst, heat from the oxidation reactions of the hydrocarbons and hydrogen causes further reforming of residual unreformed hydrocarbons.

The effluent gas from the secondary reformer is cooled from 950°-1000°C to about 375°C by passing it through a waste heat boiler where it is used to generate steam for driving related equipment (pumps, compressors, and electrical generators).

Conversion of Carbon Monoxide to Carbon Dioxide (Shift Conversion)--The residual CO in the process gas provides an opportunity to increase its hydrogen content according to the following reaction (shift conversion):

$$CO + H_2O \rightarrow CO_2 + H_2$$

The reaction, in the presence of a catalyst, is exothermic; therefore, it is usually carried out in two steps with heat removal between each step. The rate of reaction is more rapid at high temperatures, but equilibrium is more favorable at low temperatures. Thus, it is common practice to operate the first step at a higher temperature than the second so that most of the CO is converted in the first step. In the second step the CO is decreased to less than 1% (often as low as 0.2%) before the process gas is fed to the methanation step (described later). The heat produced by the shift conversion reaction is used to generate steam and to preheat boiler feedwater.

The catalyst used in this reaction also promotes the formation of traces of ammonia. This ammonia is contained in the condensate that is formed following additional heat recovery and cooling of the process gas.

Carbon Dioxide (CO_2) Removal--After the shift conversion reaction, the process gas containing about 18% or more CO_2 (depending upon the feedstock) is processed to remove most of the CO_2. The CO_2 removal may be accomplished by a variety of processes which differ mainly by the solvent that is used.

The process gas containing CO_2 flows through a column from bottom to top, countercurrent to a scrubbing solution (solvent). The scrubbing solution, enriched with CO_2, leaves the absorber and passes to a separate stripping column where the dissolved CO_2 is removed by heating the solution. The carbon dioxide recovered from the scrubbing solution is relatively pure and is suitable for the manufacture of urea and many other industrial chemicals.

Methanation--After CO_2 removal, the process gas still contains traces of CO and CO_2. These two components would poison (damage) the ammonia synthesis catalyst, and therefore they must be removed before the gas is routed to the ammonia synthesis section of the process. The removal is achieved by the methanation reactions. The process gas enters the methanator where CO and CO_2 are converted, in the presence of a catalyst, to methane according to the following exothermic reactions:

$$CO + 3H_2 \rightarrow CH_4 + H_2O$$
$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

Compression--The synthesis gas leaving the methanation step typically contains about 74% hydrogen (H_2), 24% nitrogen (N_2), 0.8% methane (CH_4), and 0.3% argon (Ar) (dry basis). The gas must be compressed to the pressure required by the synthesis step. Before centrifugal compressors came into general use, reciprocal compressors were used. These reciprocal compressors often involved as many as five stages of compression with various gas purification steps at intermediate pressures. Synthesis pressures varied widely from 100 to 800 atm (about 1,500-12,000 psi) depending on the process. Reciprocal compressors are still used for small plants (capacity of less than about 500 mtpd), but centrifugal compressors are now used in the great majority of new plants having capacities of 600-1,500 mtpd. Synthesis pressures in these new plants usually are in the range of 150-250 atm (about 2,200-3,700 psi), although some of the larger plants may operate at 300-350 atm (about 4,500-5,000 psi).

Ammonia Synthesis--The function of the final process step (ammonia synthesis) is to catalytically combine N_2 and H_2 in a 1-to-3 molecular ratio to produce ammonia (NH_3) and to separate the ammonia formed from the unreacted gas which is recirculated. The ammonia synthesis reaction ($N_2 + 3H_2 \rightarrow 2NH_3$) is carried out at 400°-450°C and is very exothermic.

Makeup synthesis gas is introduced into the synthesis loop at the point where ammonia condensation occurs. Traces of water in the makeup synthesis gas are absorbed in the liquid ammonia and thus removed.

The conversion of the synthesis gas into ammonia and recovery of the ammonia occur as a result of several passes of this gas through the synthesis loop. A portion of the synthesis gas is converted into ammonia during each pass through the loop, and a portion of the ammonia produced is removed. The unreacted synthesis gas is recompressed and returned to the loop for further conversion and recovery of ammonia in subsequent passes.

The liquid ammonia product, separated from the circulating synthesis gas loops, is cooled to minus 33°C and then transferred to an atmospheric storage tank equipped with a refrigeration system.

Urea Process Technology

All commercial urea is produced from carbon dioxide and ammonia feedstock. The carbon dioxide is obtained as a byproduct from the previously described ammonia process. The urea synthesis reaction proceeds in two steps

according to the following reactions: (1) formation of ammonium carbamate and (2) dehydration of ammonium carbamate to form urea and water.

$$\underset{\text{ammonia}}{2NH_3} + \underset{\text{carbon dioxide}}{CO_2} \rightleftarrows \underset{\text{ammonium carbamate}}{NH_2CO_2NH_4} \qquad \text{[Reaction 1]}$$

$$\underset{\text{ammonium carbamate}}{NH_2CO_2NH_4} \rightleftarrows \underset{\text{urea}}{CO(NH_2)_2} + \underset{\text{water}}{H_2O} \qquad \text{[Reaction 2]}$$

All urea processes consist of the following major process steps: (1) urea synthesis as shown in reactions [1] and [2], (2) carbamate decomposition, (3) gas recovery, (4) concentration, and (5) finishing. The gas recovery step that is used identifies which of the three major types of urea processes is used. The three processes are referred to as the (1) total-recycle process, (2) partial-recycle process, and (3) once-through process.

In the total-recycle process, the ammonia and carbon dioxide off-gases from the carbamate decomposition step are recycled back to the urea reactor. In the partial-recycle process, only a part of the off-gas from the decomposition step is returned to the urea reactor, and in the once-through process none of the off-gases are returned to the urea reactor. In the partial-recycle and once-through processes, the ammonia in the off-gas must be recovered and utilized in another plant that is located nearby, such as an ammonium nitrate, ammonium sulfate, or ammonium phosphate production unit. In the case of urea and DAP production in Cameroon, a total-recycle urea process is recommended to provide maximum flexibility in urea production even if the DAP plant is shut down due to a shortage of imported phosphoric acid or for other reasons.

Total-Recycle Urea Process--A typical flow diagram of the total-recycle process including the production of a concentrated urea solution "melt" is shown in Figure III-2. In the process compressed ammonia and carbon dioxide are fed to a urea reactor which is operated at about 185°C and 200 atm (3,000 psi). The effluent solution from the urea reactor contains urea, water, unconverted ammonium carbamate, and ammonia. The two latter ingredients are separated from the urea solution by decomposition to ammonia and carbon dioxide in two or three stages by heating at successively lower pressures. In each stage the evolved gas mixture is condensed (or absorbed in urea solution), and the resulting carbamate solution is recycled to the urea reactor. The urea solution from the last

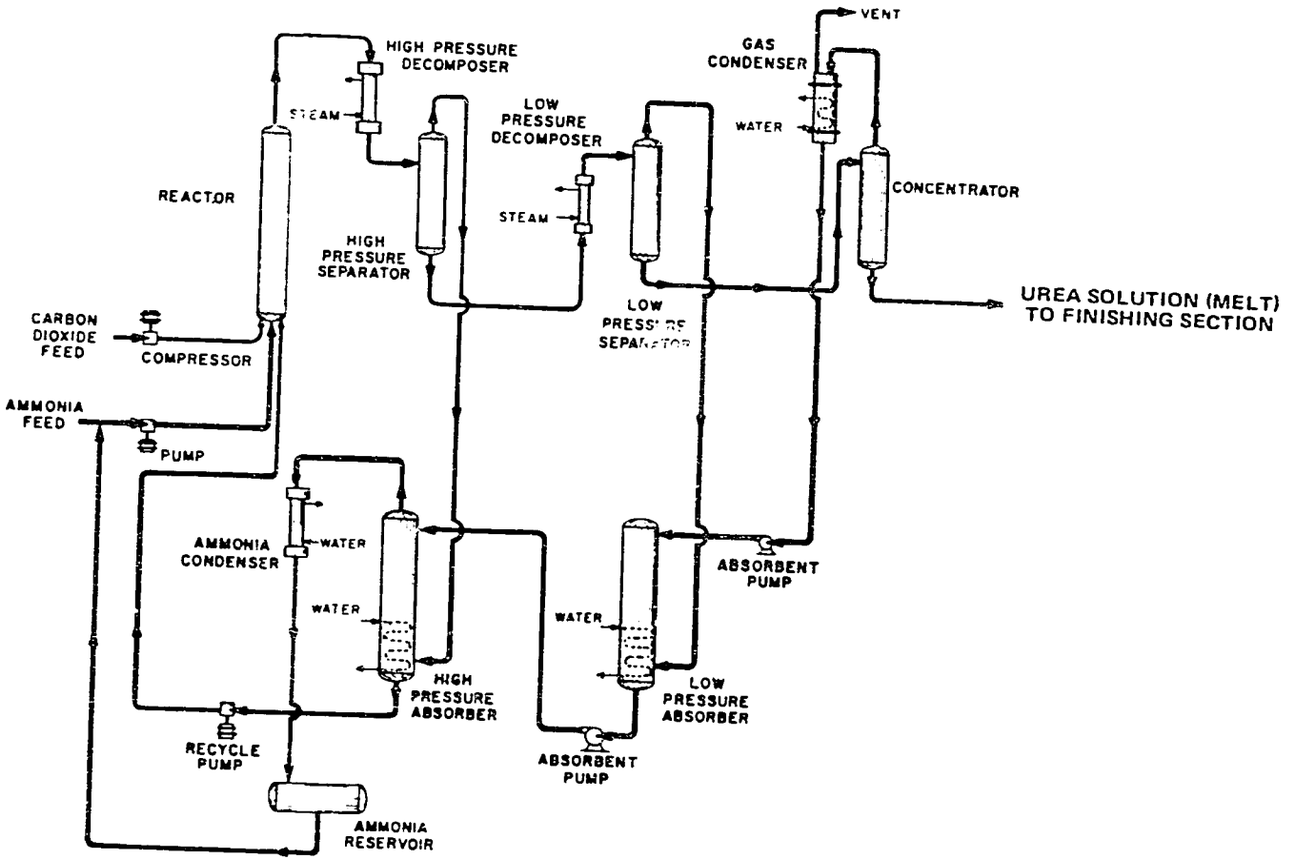


Figure III-2. Typical Flow Diagram—Total Recycle Urea Synthesis Process.

decomposition/separation stage, containing about 75% urea and 25% water solution, is concentrated to 95%-99% urea by evaporation before it is fed to the finishing section of the process where a solid product is formed.

Urea Finishing Processes--The most common urea finishing process is prilling. In this process the molten urea (melt) is discharged through a perforated basket (prilling bucket) located in the top of a tall tower. Small droplets of molten urea discharged from the perforated basket fall through an upward flow of cooling air in the tower and solidify into small particles, (prills) usually 1.0-1.5 mm in diameter, before reaching the bottom of the tower. The prills are removed on a continuous basis from the tower, screened (optional), and routed to storage/bagging. In most cases the prills are cooled to about 40°-45°C to minimize caking during storage. In most processes the cooling is performed before screening; in others, additional cooling may be performed after screening.

In recent years (since about 1970) several granulation processes have emerged and are slowly replacing the traditional prilling process. The most advanced and widely used urea granulation processes are the Spherodizer® and fluidized/spouted bed processes. A process flow diagram of each of these processes is shown in Figures III-3 and III-4. The Spherodizer® process is well established in the United States and Canada, and variations of the fluidized/spouted bed processes are being operated or are under construction in Canada, Central America, Malaysia, New Zealand, and the Netherlands.

The major advantages of granular urea over prilled urea are that granular urea is (1) larger in particle size and therefore better suited for preparing nonsegregating bulk blends with other granular materials such as DAP and potash (discussed later), (2) stronger and more resistant to breakage, and (3) easier to handle and apply because it is more free flowing than prills. In the proposed Cameroon project a modern urea granulation process is recommended instead of the traditional prilling process. The investment and operating cost is not significantly different for the two processes (prilling or granulation).

Diammonium Phosphate Process Technology

The production of DAP involves the reaction of ammonia (NH_3) and phosphoric acid (H_3PO_4) according to the following equation:

$$\underset{\text{ammonia}}{2NH_3} + \underset{\text{phosphoric acid}}{H_3PO_4} \rightarrow \underset{\text{diammonium phosphate}}{(NH_4)_2HPO_4}$$

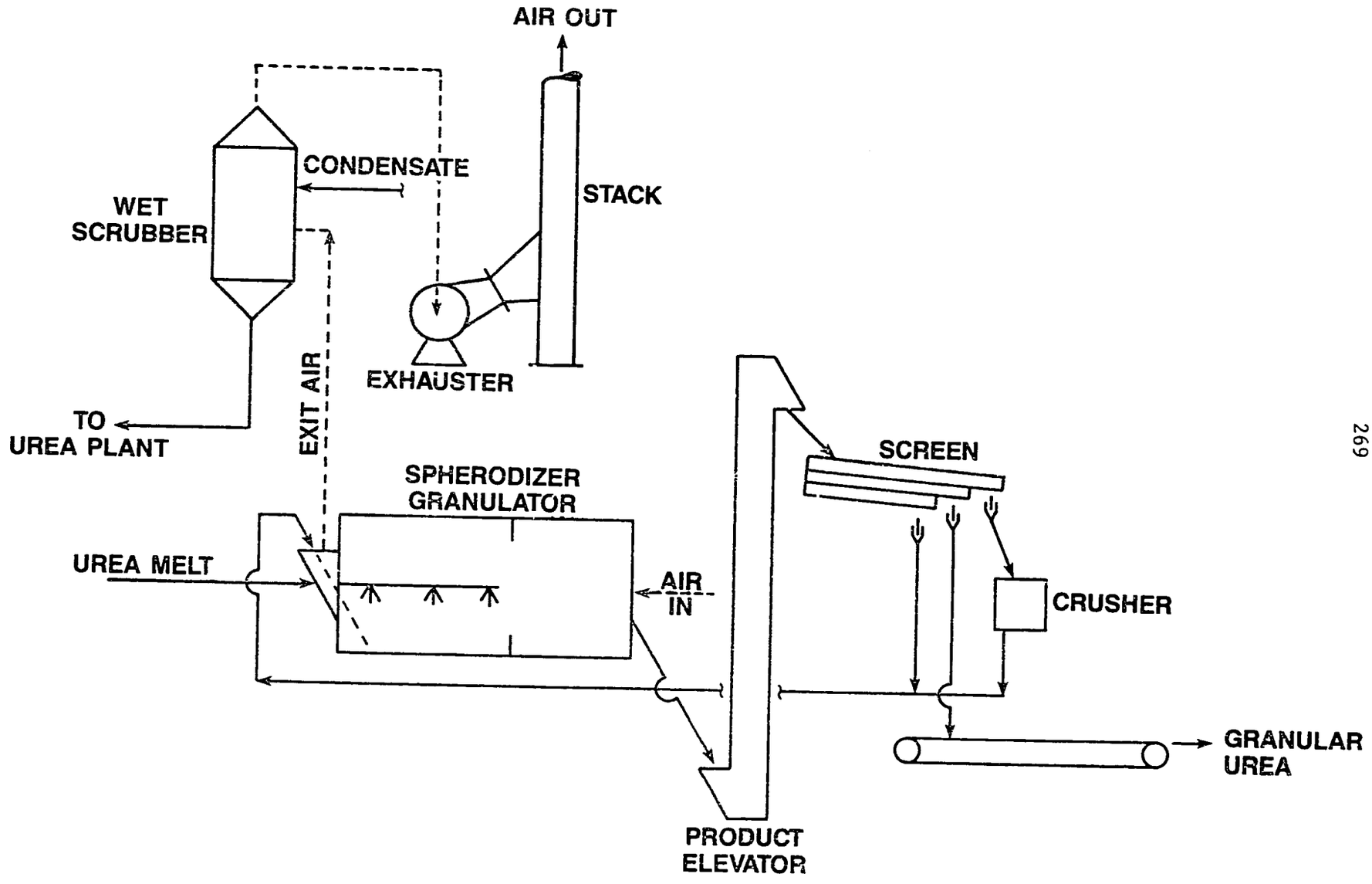


Figure III-3. C&I Girdler Urea Spherodizer® Granulation Process.

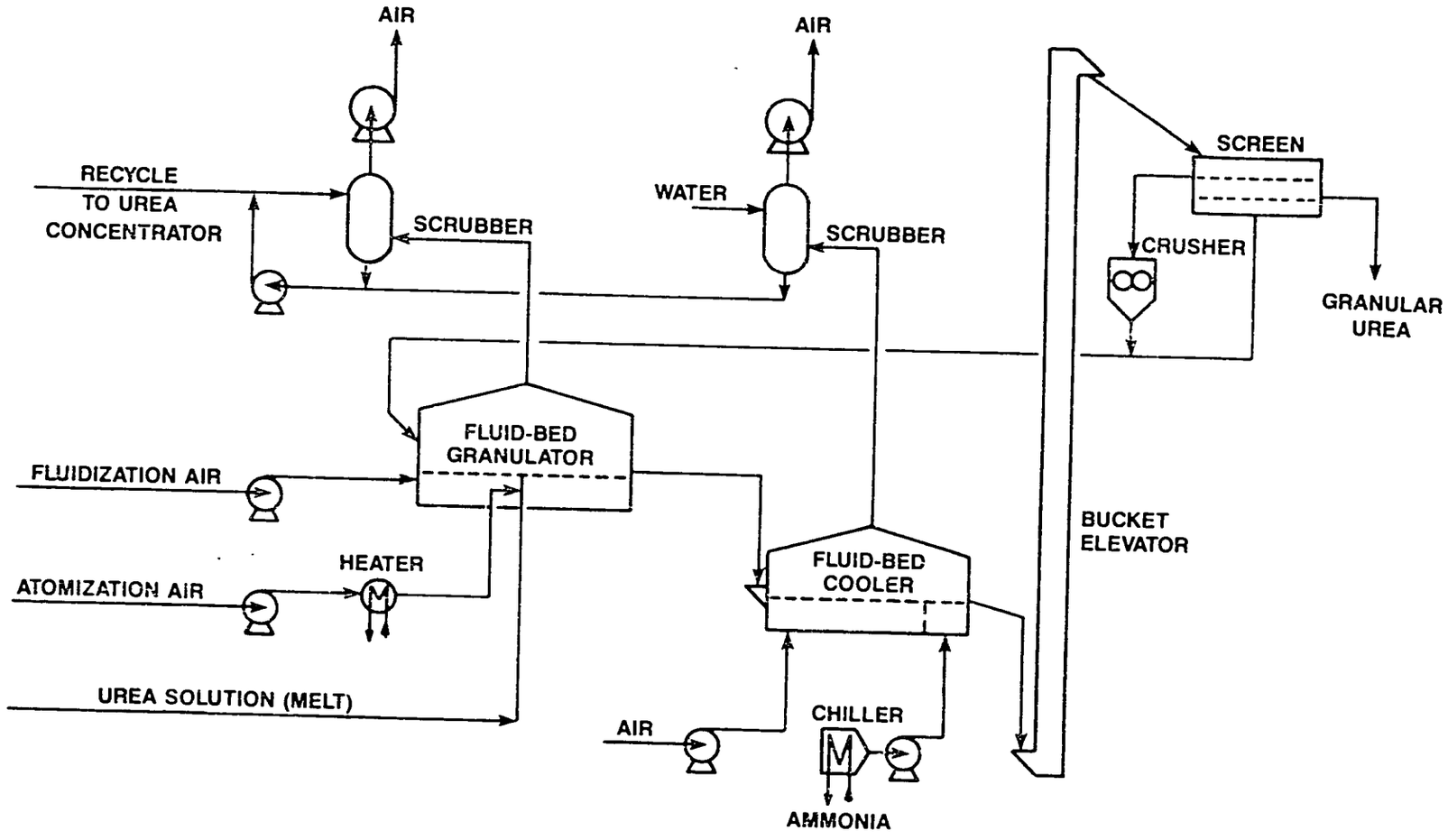


Figure III-4. Typical Fluidized-Bed Urea Granulation Process.

About 0.23 mt of NH_3 and about 0.76 mt of phosphoric acid (dry basis) are required to produce 1 mt of DAP.

In the DAP granulation process shown in Figure III-5, which is operated on a continuous basis, ammonia and phosphoric acid (containing about 20% water) are partially reacted in the form of a hot (about 115°C, 240°F) slurry. The slurry is sprayed onto a moving (rolling) bed of recycled solid DAP in a granulator (usually a rotary drum- or pug mill-type unit). Additional ammonia is added to the granulator to adjust the NH_3:H_3PO_4 mole ratio to near 2.0 which is the theoretical ratio for DAP. At this stage in the process the DAP material is still moist (about 3% H_2O). It is then dried to about 1% H_2O, screened to separate the product-sized material from the total in-process material, and finally cooled before it is routed to storage or bagging. The material that is less than product size is returned (recycled) to the granulator.

The DAP plant can be designed to produce MAP without modification or change in capacity. This flexibility in design is recommended for the Cameroon unit because of the anticipated need for both DAP and MAP in preparing some of the recommended high phosphate-containing bulk-blended products.

Raw Material Supply

A description of the source and composition of the raw materials required for the production of ammonia, urea, and DAP follows.

Natural Gas--As previously described, in addition to air and water, natural gas (methane, CH_4) is the only major raw material that must be provided to produce ammonia.

Cameroon has large offshore resources of nonassociated and associated natural gas. Nonassociated gas from reserves in Cameroon are estimated at about 100 billion m^3. Two-thirds of these reserves lie in the northern coastal region around the Rio del Rey oil fields. The remaining third is located in the southern coastal region near the town of Kribi. None of the nonassociated gas reserves have been exploited. A project currently under consideration is to build a liquefied natural gas (LNG) plant at Kribi with a capacity of 4 billion m^3/year. The LNG would be exported. The LNG project is managed by Societe d'Etudes du Gaz du Cameroun (SOGAZCAM), a consortium of foreign oil companies and the Cameroon Government. The project implementation, however, has been postponed because of the uncertainties surrounding the gas market, especially the expected decline in demand for LNG in Western Europe.

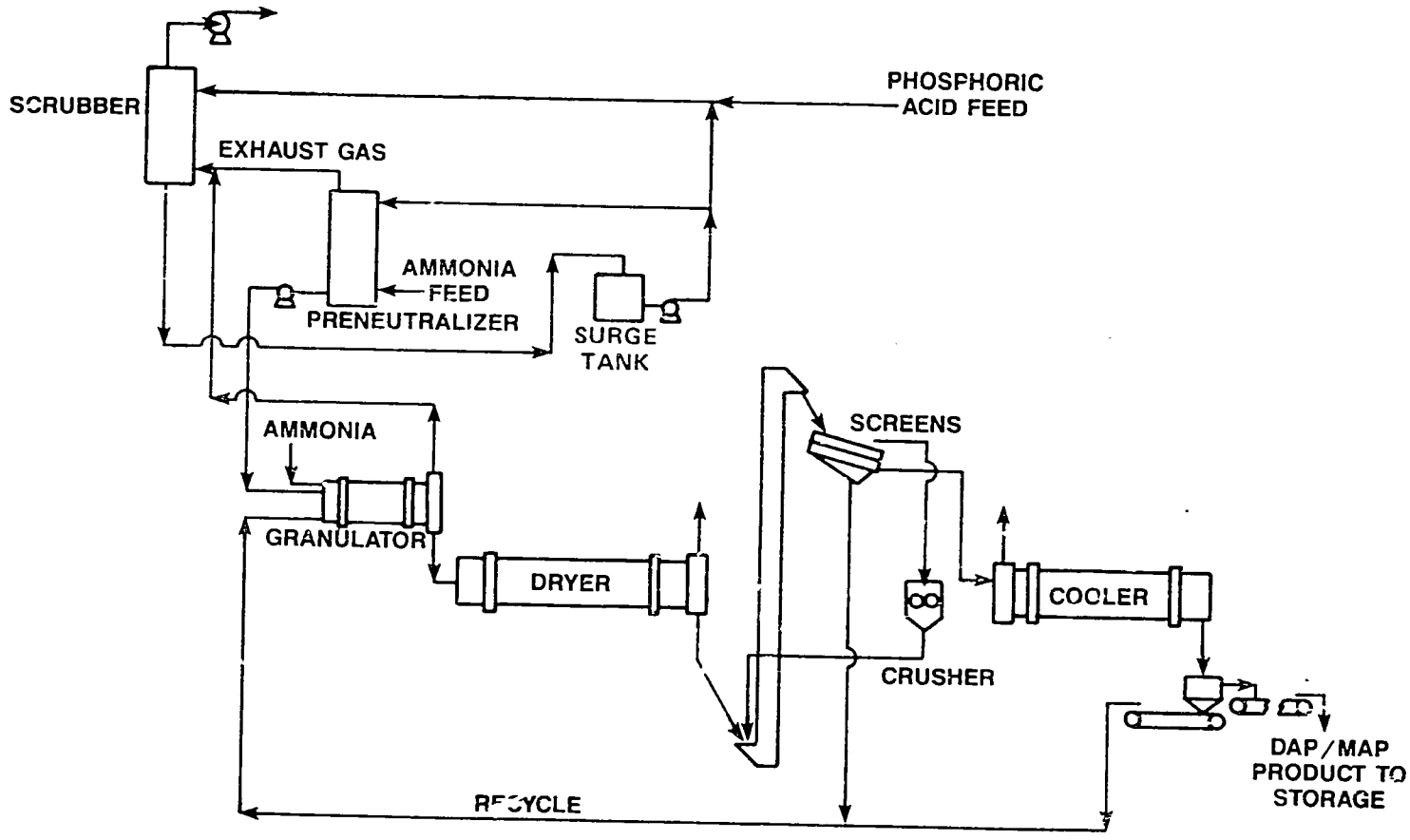


Figure III-5. Typical DAP/MAP Granulation Process.

Associated gas is currently being flared from different points of the Rio del Rey oil fields, about 80 km from Limbe. The flaring rate according to the Societe National des Hydrocarbures (SNH) is estimated at 2.5 million m^3/day.

There also have been reports of some natural gas reserves about 10 km offshore from the port city of Douala. However, the extent of these reserves is not accurately known.

According to the Ministry of Commerce and Industry, Norsk Hydro of Norway is performing a feasibility study of a 1,500-mtpd ammonia plant based on natural gas from Kribi. A small portion of ammonia output would be used to produce urea for the local market, and the remaining ammonia would be for export. It is expected that the Norsk Hydro study will be completed in early 1986.

For the purpose of the IFDC evaluation, it is assumed that the natural gas would be supplied from the Kribi reserves.

Phosphoric Acid--The phosphoric acid required for the DAP plant would be imported. Merchant-grade wet-process phosphoric acid containing about 54% P_2O_5 would be delivered in ship tankers to the proposed jetty near Kribi. The acid would be discharged by pipeline into storage tanks located inside the ammonia/urea/DAP complex. The proposed DAP plant would have an annual capacity of 45,000 mt (discussed later) and would require about 38,000 mtpy of acid. This is equivalent to about five 8,000-mt tankers per year. The typical specifications for merchant-grade wet-process phosphoric acid suitable for producing DAP are shown in Table III-1.

Plant Capacity

The overall plant capacity is based on 200 mtpd and 1,000 mtpd of ammonia for the small and large complexes, respectively. The total ammonia production is used to produce urea and DAP. Since DAP is based on imported phosphoric acid, its production cost is high in comparison with the world market price, and it is not competitive in the export market. Therefore, for this reason, the DAP plant capacity was established on the basis of the projected (1995) domestic need for phosphate (either DAP or MAP). The capacity of the urea plant was established by subtracting the amount of ammonia needed for the production of DAP. The balance of ammonia was converted into urea.

As indicated later (Table III-12), the 1991 combined demand projection for MAP and DAP for bulk blending is 28,200 mt. The proposed DAP plant can produce MAP as a replacement for DAP without modification of the plant or loss

Table III-1. Typical Specification for Merchant-Grade Wet-Process Phosphoric Acid Suitable for Production of DAP

Constituent	Typical Analysis, % by Weight
P_2O_5	52-54[a]
CaO	0.1-1.2
Fe_2O_3	1.7-3.5
Al_2O_3	1.5-2.7
MgO	0.60-1.1
Na_2O	0.18-0.45
K_2O	0.16-0.31
SiO_2	0.60-1.2
F	1.0-3.0
Cl	0.01-0.05
SO_3	2.3-5.2
Undissolved solids	0.5-2.0

a. Acid diluted with water to as low as 45% P_2O_5 may be suitable for some DAP production processes.

Source: IFDC.

of production. Assuming a growth rate of about 7%/year, the combined demand for MAP and DAP in 1995 is expected to be about 45,000 mt which corresponds to a design capacity of 150 mtpd DAP, assuming the plant operates 300 days/year.

The ammonia that is not used to produce ammonium phosphate (MAP or DAP) is used to produce urea at a rate of 280 mtpd and 1,650 mtpd in the small and large complexes, respectively. This corresponds to an annual urea capacity of 84,000 mt and 495,000 mt for the small and large complexes, respectively. The 84,000 mtpy of urea produced in the small complex corresponds to the approximate domestic demand projection for urea in 1995. In the large complex, the excess urea capacity would be available for export. In 1995 the amount of urea available for export is estimated at about 411,000 mt or about 83% of the total urea output.

The storage capacities for raw materials, intermediates, and finished products were determined on the basis of 5 days' production for ammonia, 60 days' DAP production for imported phosphoric acid (54% P_2O_5), 45 days' production for bulk products (MAP/DAP and urea), and 15 days' production for bagged products (MAP/DAP and urea).

The capacities of the process plants and storage facilities for both complexes are summarized as follows:

	Small Complex	Large Complex
Process plant, mtpd		
Ammonia	200	1,000
Urea	280	1,650
MAP/DAP	150	150
Storage facilities, mt		
Ammonia	1,000	5,000
Phosphoric acid	8,000	8,000
Bulk products	20,000	82,000
Bagged products	7,000	27,000

Plant Location

The following criteria should be met when selecting the site for the proposed ammonia/urea/DAP factory:

1. A reliable long-term (at least 20 years), cost-effective supply of natural gas for fuel and feedstock (about 7 billion m^3 for a 1,000-mtpd ammonia plant) must be ensured.

2. Site must be feasible for development of a deep-water port or jetty for shipment of finished products and for receiving phosphoric acid for DAP production.
3. About 20 ha of land for the small complex (60,000 mtpy ammonia) and about 50 ha for the large complex (300,000 mtpy ammonia) are required. Additional land should also be available for expansion or for the location of other industries that could share some of the infrastructure and thus decrease the costs charged directly to the fertilizer project.
4. Fresh water must be available at a rate of about 6,000 m^3/day for the small complex and about 30,000 m^3/day for the large complex.

Availability of electricity was not considered as a criterion for the complex because the power-generating facility is assumed to be included as an integral part of the proposed complex. The power-generating facility would use natural gas fuel.

Both the Kribi and Limbe sites appear to satisfy the above criteria. Therefore the cost of natural gas is the determining factor. Unless it can be shown that the recovery of associated gas at Limbe is less costly than the exploitation cost of unassociated natural gas at Kribi, it is assumed for this study that the complex would be located at Kribi. One of the disadvantages of the Kribi site is that it is farther from the local market. However, this disadvantage is minimized if the project is designed primarily for exportation of urea.

Production Economics for Ammonia/Urea/DAP Complex

Capital investment and production cost estimates were developed for the small and large ammonia/urea/DAP production complexes. The production costs were compared with the world market prices to determine the project viability. The premises and assumptions used for preparing the cost estimates are included in Appendix M.

Capital Investment Estimates

The capital investment estimates for the small and large ammonia/urea/DAP complexes are shown in Table III-2. The fixed capital estimates (1985 cost basis) are about US $176 million and $413 million, respectively, for the small

Table III-2. Capital Investment Estimate for Ammonia/Urea/DAP Complex

Premises

1. Cost basis: 1985 US$
2. Plant capacity:

	Small Complex		Large Complex	
	(mtpd)	(mtpy)	(mtpd)	(mtpy)
Ammonia	200	60,000	1,000	300,000
Urea	280	84,000	1,650	495,000
DAP	150	45,000	150	45,000

Item	Investment Cost	
	Small Complex	Large Complex
	- - - -(US$ x 1 million)- - - -	
Battery limits process units		
Ammonia	35.0	90.0
Urea	24.0	58.0
DAP	8.0	8.0
Subtotal	67.0	156.0
Raw material/product storage and handling facilities	10.0	20.0
Auxiliary and support facilities[a]	33.5	78.0
Site development[b]	6.6	15.2
Contingencies[c]	17.6	40.4
Total installed cost	134.7	309.6
Preoperational and startup cost[d]	10.1	14.0
Project management services[e]	8.1	12.4
Interest during construction[f]	22.9	77.3
Total fixed capital investment	175.8	413.3
Working capital	15.0	33.0
Total capital investment	190.8	446.3

a. Based on 50% of battery limits process unit cost.
b. Based on 6% of investment cost for battery limits process units, storage and handling facilities, and auxiliary and support facilities.
c. Based on 15% of all above costs.
d. Based on 10% and 6% of investment for battery limits process units and auxiliary facilities for small and large complexes, respectively.
e. Based on 6% and 4% of total installed cost for small and large complexes, respectively.
f. Based on 15% and 23% of all above costs for small and large complexes, respectively.

Source: IFDC.

and large complexes. The corresponding working capital estimates for the two complexes are $15 million and $33 million, bringing the total capital investment estimates to $191 million and $446 million for the small and large complexes, respectively.

The allocated capital costs for urea and DAP for both complexes are shown in Table III-3. These allocated costs are used in estimating the production cost for each product (urea and DAP).

Production Cost Estimates

The production cost estimates, including capital recovery, for urea and DAP produced in the small and large complexes are shown in Tables III-4 and III-5, respectively. The annual production rates for the small complex are 84,000 mt urea and 45,000 mt DAP; those for the large complex are 475,000 mt urea and 45,000 mt DAP. These production rates correspond to 300 operating days per year at design capacity or about 90% capacity utilization. Such a capacity utilization is commonly used in preparing preliminary economic evaluations.

Using a base-case delivered price of $1.5/million Btu for natural gas and $270/mt ($500/mt P_2O_5) for 54% P_2O_5 phosphoric acid (Appendix M), the production costs of bagged urea and DAP produced in the two complexes are summarized as follows:

	Small Complex	Large Complex
	(US $/mt)	
Urea	466.3	236.8
DAP	424.9	388.4

The effect (sensitivity) of raw material prices (natural gas and phosphoric acid) on the production cost estimates is shown in Tables III-6 and III-7 and on Figures III-6 and III-7. In the small complex a change of US $0.5/million Btu in the natural gas price will result in a change of about US $14/mt for urea and about US $5/mt for DAP. This represents about a 3.0% and a 1.1% change in the production cost of urea and DAP, respectively. In the large complex, a US $0.5/million Btu change in natural gas price results in a change of about 5.9% (US $14/mt) and about 1.3% (US $5.0/mt) in the production costs of urea and DAP, respectively.

Phosphoric acid accounts for about 55% and 60% of the total production cost in the small and large complex, respectively. A 20% change ($100/mt P_2O_5)

Table III-3. Allocation of Capital Investment Cost for Urea and DAP

Allocated Cost	Small Complex		Large Complex	
	Urea	DAP	Urea	DAP
Fixed capital[a]	148.8	27.0	392.3	21.0
Working capital	9.0	6.0	28.0	5.0
Subtotal (allocation)	157.8	33.0	420.3	26.0
Total capital investment	190.8		446.3	

a. Allocated installed costs for urea and DAP are $114.0 and $20.7 million, respectively, for small complex and $294.1 and $15.5 million for urea and DAP, respectively, for large complex.

Source: IFDC.

Table III-4. Production Cost Estimate for Small Ammonia/Urea/DAP Complex

Premises:
1. Cost basis 1985 US $
2. Capital investment (refer to Tables III-2 and III-3)
3. Annual production: Urea--84,000 mt
   DAP--45,000 mt
4. Material costs: Natural gas--$1.5/million Btu (US $6.0/million kcal)
   Phosphoric acid (54% P_2O_5)--$270/mt ($500/mt P_2O_5)
   50 kg bags--$0.6 each

Cost Item	Urea			DAP		
	Basis	US $/mt	Annual Cost, US $ x 1 Million	Basis	US $/mt	Annual Cost, US $ x 1 Million
Variable Cost						
Natural gas	29 million Btu[a]	43.5		10.5 million Btu[a]	15.8	
Phosphoric acid	-			0.47 mt P_2O_5[a]	235.0	
Catalyst, chemicals, and supplies	US $4.0[a]	4.0		US $1.5[a]	1.5	
Bags	20[a]	12.0		20[a]	12.0	
Subtotal		59.5			264.3	
Fixed Cost						
Operating and maintenance labor	150% labor		1.20	150% labor		0.40
Administration and general overheads	3% of $114.0 million		1.80	3% of $20.7 million		0.60
Maintenance materials	1% of $114.0 million		3.42	1% of $20.7 million		0.62
Insurance	17.1% of $148.8 million		1.14	17.1% of $27.0 million		0.21
Fixed capital recovery	13% of $9.0 million		25.44	13% of $6.0 million		4.62
Interest on working capital			1.17			0.78
Subtotal		406.8	34.17		160.6	7.23
Total production cost		466.3			424.9	

a. Per mt of product.

Source: IFDC.

Table III-5. Production Cost Estimate for Large Ammonia/Urea/DAP Complex

Premises:
1. Cost basis 1985 US $
2. Capital investment (refer to Tables III-2 and III-3)
3. Annual production: Urea--495,000 mt
   DAP--45,000 mt
4. Material costs: Natural gas--$1.5/million Btu (US $6.0/million kcal)
   Phosphoric acid (54% P_2O_5)--$270/mt ($500/mt P_2O_5)
   50 kg bags--$0.6 each

Cost Item	Urea			DAP		
	Basis	US $/mt	Annual Cost, US $ x 1 Million	Basis	US $/mt	Annual Cost, US $ x 1 Million
Variable Cost						
Natural gas	27 million Btu[a]	40.5		10 million Btu[a]	15.0	
Phosphoric acid	-	-		0.47 mt P_2O_5[a]	235.0	
Catalyst, chemicals, and supplies	US $4.0[a]	4.0		US $1.5[a]	1.5	
Bags	20[a]	12.0		20[a]	12.0	
Subtotal		56.5			263.5	
Fixed Cost						
Operating and maintenance labor			2.70			0.30
Administration and general overheads	150% labor		4.05			0.45
Maintenance materials	3% of $294.1 million		8.82	3% of $15.5 million		0.47
Insurance	1% of $294.1 million		2.94	1% of $15.5 million		0.16
Fixed capital recovery	17.1% of $392.3 million		67.08	17.1% of $21.0 million		3.59
Interest on working capital	13% of $28.0 million		3.64	13% of $5.0 million		0.65
Subtotal		180.3	89.23		124.9	5.62
Total production cost		236.8			388.4	

a. Per mt of product.

Source: IFDC.

Table III-6. Effect of Natural Gas Price on Production Cost of Urea and DAP

Premises: 1. Cost basis: 1985 US $
2. Phosphoric acid price (54% P_2O_5): $270/mt ($500/mt P_2O_5)

Natural Gas Price, (US $/Million Btu)	Small Complex		Large Complex	
	Urea	DAP	Urea	DAP
	(US $/mt)		(US $/mt)	
0.0	423	409	196	373
0.5	437	414	210	378
1.0	452	420	223	383
1.5 (base case)[a]	466	425	237	388
2.0	481	430	250	393
2.5	495	435	264	398
3.0	510	441	277	403
4.0	539	451	304	413

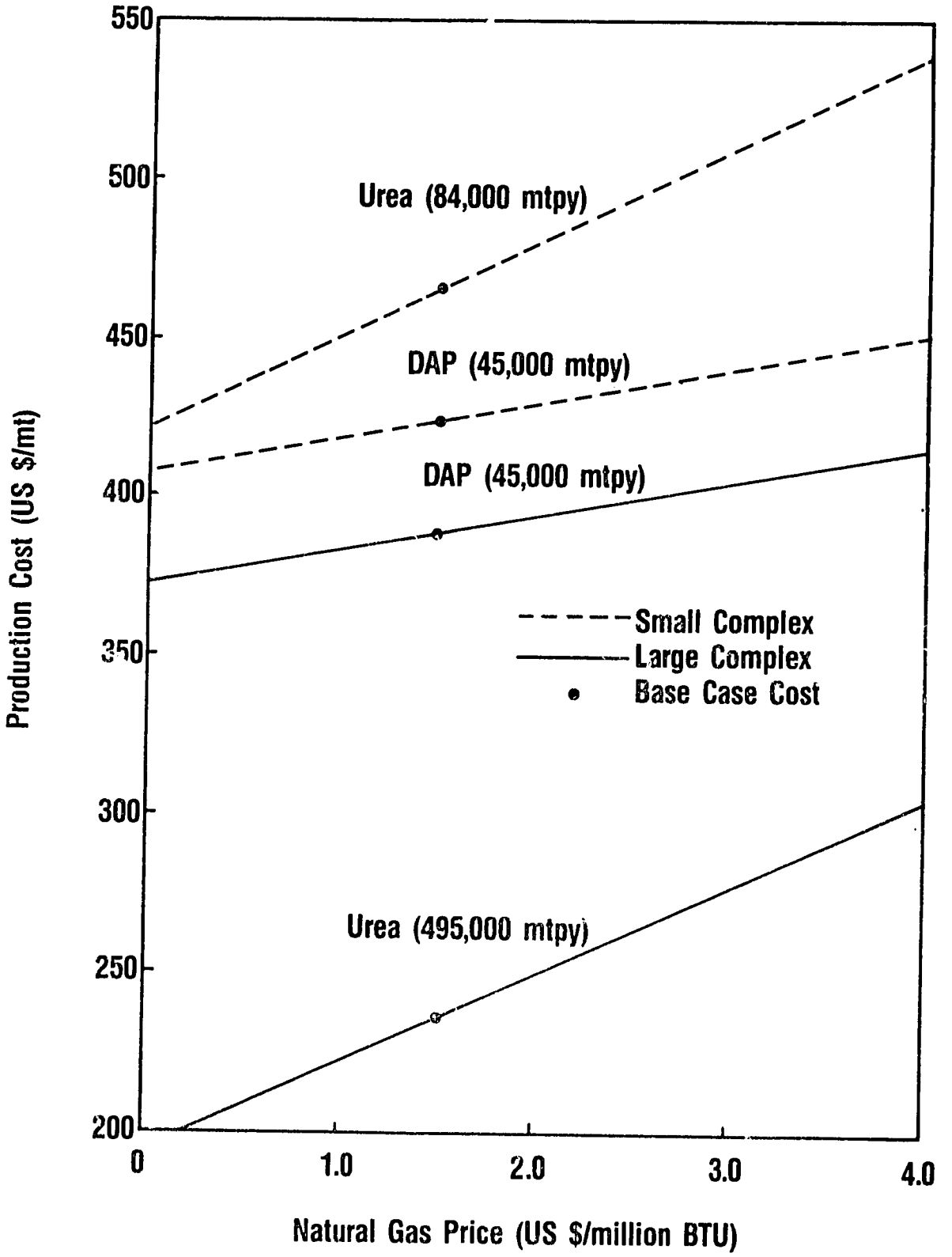
a. US $1.5/million Btu is equivalent to US $6.0/million kcal.

Table III-7. Effect of Phosphoric Acid Price on Production Cost of DAP

Premises: 1. Cost basis: 1985 US $
2. Natural gas price: US $1.5/million Btu (US $6.0/million kcal)

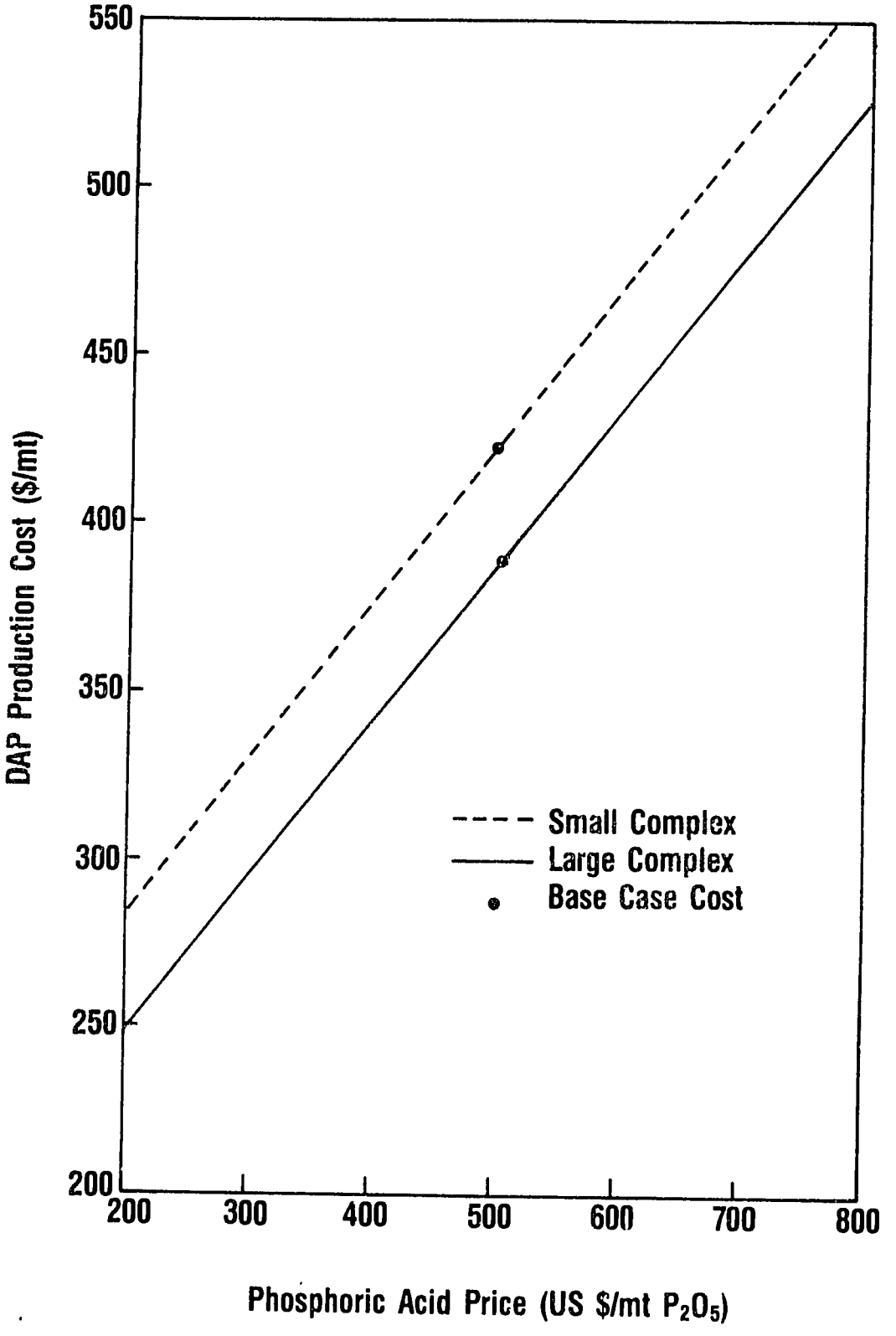
Phosphoric Acid Price, (US $/mt P_2O_5)	DAP Production Cost	
	Small Complex	Large Complex
	($/mt)	
300	331	294
400	378	341
500 (base case)	425	388
600	472	435
700	519	482

Source: IFDC.



Source: IFDC.

Figure III-6. Effect of Natural Gas Price on Urea and DAP Production Cost in Small and Large Urea Complex.



Source: IFDC.

Figure III-7. Effect of Phosphoric Acid Price on DAP Production Cost in Small and Large Urea Complex.

in the price of phosphoric acid results in a $47/mt change in the DAP production cost. This corresponds to a change of 11.0% and 12.1% in the production cost for the small and large complexes, respectively.

The sensitivity of the urea and DAP production costs with changes in capacity utilization for the small and large complexes is shown in Table III-8.

Comparison of Cameroon Urea and DAP Production Costs With World Market Prices

The prices of fertilizer for comparison with the production costs are different for the local and export market. If a fertilizer product is consumed locally, its production cost should be compared with the delivered price of a comparable imported product. However, if it is to be exported, its production cost should be compared with the world market export (f.o.b.) price.

Therefore, on the basis of this criterion, the production costs of urea in the small complex and DAP in both the small and large complexes should be compared with the delivered prices of imported urea and DAP. In the large complex, however, urea is produced mainly for the export market; therefore, its production cost should be compared with the world market export (f.o.b.) price.

The base-case estimated cost of producing urea in the small complex is $466/mt (Table III-4), which is about twice the delivered price of imported urea when using the most cost-effective importation scheme (US $234/mt, Table III-19). The base-case production costs of DAP in the small and large complexes are US $425/mt (Table III-4) and US $388/mt (Table III-5), respectively. These costs are higher by about 1.4 and 1.3 times, respectively, than the estimated delivered price of imported DAP (US $301/mt, Table III-19). Thus, the small complex is not feasible.

The cost of producing granular bagged urea in the large complex is estimated at about US $237/mt (Table III-5) if natural gas is priced at US $1.50/million Btu (base case value used for estimate). This cost is about 1.7 times the current prevailing f.o.b. world price of about US $140/mt (in bags) as shown later (Table III-19). If natural gas is priced at zero (Table III-6), then the cost of urea would still be about 1.4 times the current prevailing f.o.b. price.

The world market (export) price of bulk urea has fluctuated widely (approximately fivefold) during the past 12 years, ranging (in 1985 constant US $) from a high of about US $500/mt to a low of about US $100/mt. The trend in the world f.o.b. price (in 1985 constant US $) of bulk urea is shown in

Table III-8. Effect of Capacity Utilization on Production Cost of Urea and DAP

Premises:
1. Cost basis: 1985 US $
2. Natural gas price: US $1.5/million Btu (US $6.0/million kcal)
3. Phosphoric acid price (54% P_2O_5): US $270/mt (US $500/mt P_2O_5)

Capacity Utilization (%)	Production Rate (mtpy)		Production Cost (US $/mt)	
	Urea	DAP	Urea	DAP
Small Complex				
90 (base case)	84,000	45,000	466	425
80	74,700	40,000	517	445
70	65,300	35,000	583	471
60	56,000	30,000	670	505
50	46,700	25,000	792	553
Large Complex				
90 (base case)	495,000	45,000	237	388
80	440,000	40,000	259	404
70	385,000	35,000	288	424
60	330,000	30,000	327	451
50	275,000	25,000	381	488

Source: IFDC.

Figure III-8. It is expected from the data shown in Figure III-8 that the average price of urea in the next 15 years will be considerably higher than the current depressed price; however, it is difficult to predict this with certainty. Therefore, it is likely that the proposed large urea complex could be feasible if the world market price of urea improves in the future and if the Government of Cameroon fixes the price of natural gas for the complex at an appropriate level to accommodate fluctuations in the world market price of urea.

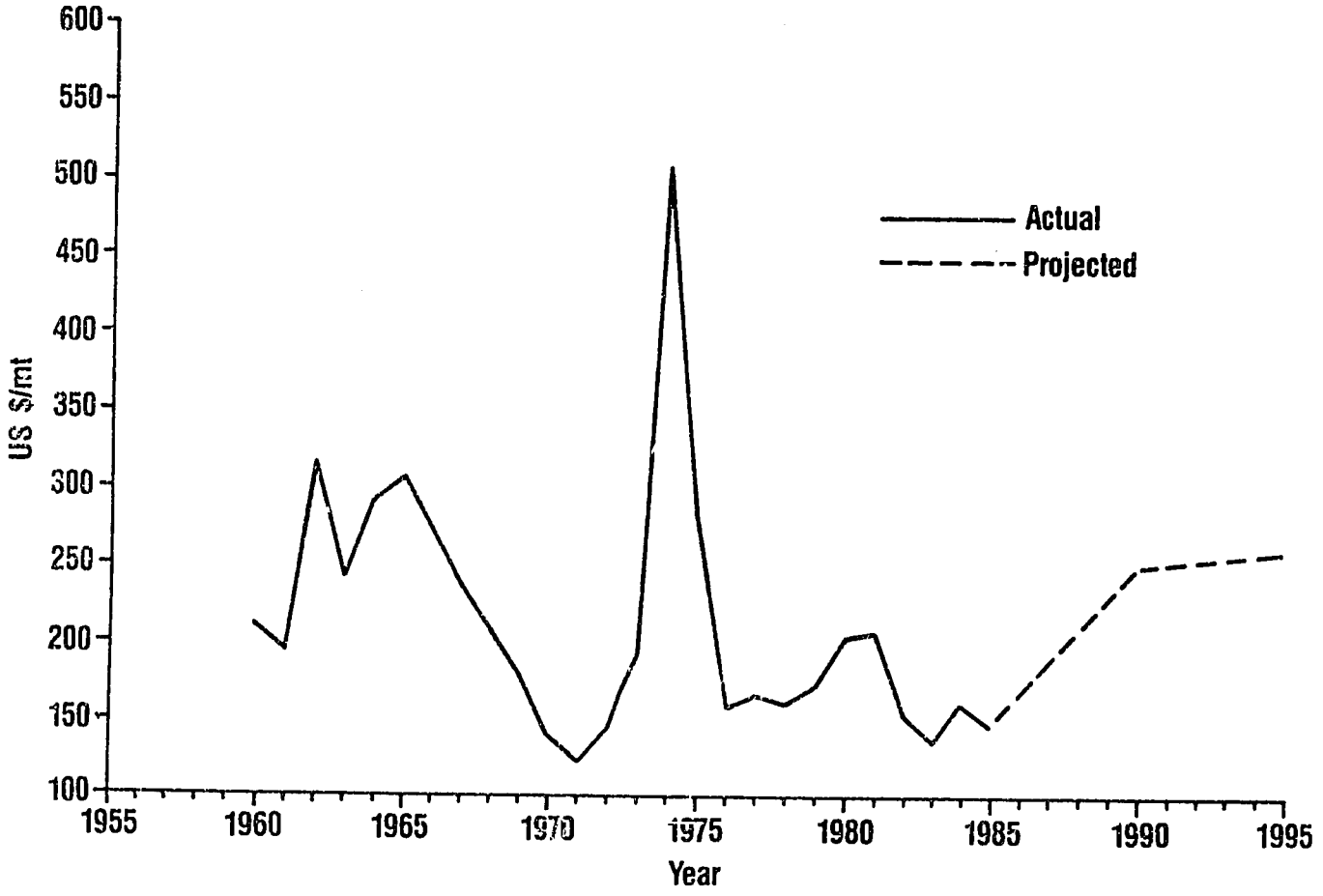
Bulk Blending and Bagging

The technical and economic feasibility of using bulk-blending technology to supply a portion of Cameroon's fertilizer needs was examined. The following discussion describes the technical advantages and limitations of bulk blending and offers recommendations for overcoming the identified obstacles. Likewise, the economics of various production alternatives, including the bagging of bulk fertilizers, is described.

Definition of Bulk Blending

The term "bulk blending" as used in this discussion refers to the physical mixing of a number of dry fertilizer materials to obtain a desired nutrient ratio and concentration. In most cases, the fertilizer raw materials used for bulk blending should be in a granular form (usually between about 1-3 mm in particle size). However, in some locations mixtures of powdered and granular or semigranular materials are often used. For example, in Malaysia about 0.5 million mt of powdered or semigranular NPK mixtures is used to fertilize rubber and oil palm.

The particle size required to prepare acceptable bulk blends is largely dependent upon local cropping conditions and farmer preferences. For example, for fertilizing most short-term, heavy-feeding crops, a well-mixed, homogeneous blend is preferred to ensure an abundant supply of nutrients in the correct proportion during a relatively short growing season. Such blends are usually prepared by using granular raw materials that are closely matched with respect to particle size. This close matching minimizes separation (segregation) of the individual materials during handling, transportation, and field application. However, with some tree crops (rubber and oil palm, for example) and some other



Source: World Bank and IFDC.

Figure III-8. Trend in F.O.B. World Market Price of Bulk Urea Expressed in 1985 Constant U.S. Dollars.

long-term crops such as sugarcane, the uniformity of the mixture is not as critical, and the use of less homogeneous mixtures prepared from less expensive, and often less soluble, materials (phosphate rock, for example) may be feasible. However, for the Cameroon conditions (crops and existing farmer preference), the use of high-quality, granular raw materials is recommended and such materials will be considered as the only alternative for the purpose of this study.

Description of Process and Equipment

A process flow diagram of the bulk-blending plant proposed for this study is shown in Figure III-9. A diagram of this system integrated with bulk unloading and bagging is shown in Figure III-10.

In the bulk-blending process, raw materials are reclaimed from bulk storage by use of a motor-driven, front-end loader (payloader). The material is dumped into a lump breaker. This unit is used to crush lumps that normally form during storage. This type of lump formation is usually referred to as "pile set" (a mechanical bonding of granular materials); however, some lumps may also form from "crusting" of the pile surface or as a result of caking caused by absorption of atmospheric moisture or because of other characteristics of the material. The lump breaker is designed to gently crush lumpy material while inflicting only a minimum amount of damage to the granules.

The material from the lump breaker is elevated into a multicompartment hopper system (cluster hopper) with a bucket elevator. The bucket elevator is fitted with a steel link-type chain and metal buckets. The speed of the chain and the size and configuration of the bucket are designed to minimize degradation of the material. The capacity of the bucket elevator is much greater than the average capacity of the blending unit since it is usually fed on an intermittent basis and must therefore be designed to accommodate short-term surges.

The raw material proportioning (weighing) and mixing steps are performed on a batch basis. Manually operated discharge gates on the cluster hopper are used to sequentially weigh the various raw materials (ingredients) into a weigh hopper located directly below the cluster hopper unit. After the total batch is weighed, the material is discharged into a mixer. The mixer is fitted with internal mixing baffles or paddles and a discharge chute assembly. The mixer has a normal working capacity of 2-5 mt depending on design capacity. After an appropriate period of mixing (usually 2-4 minutes on a batch-wise basis), the material (product) is discharged and conveyed to the bagging area. Micronutrients,

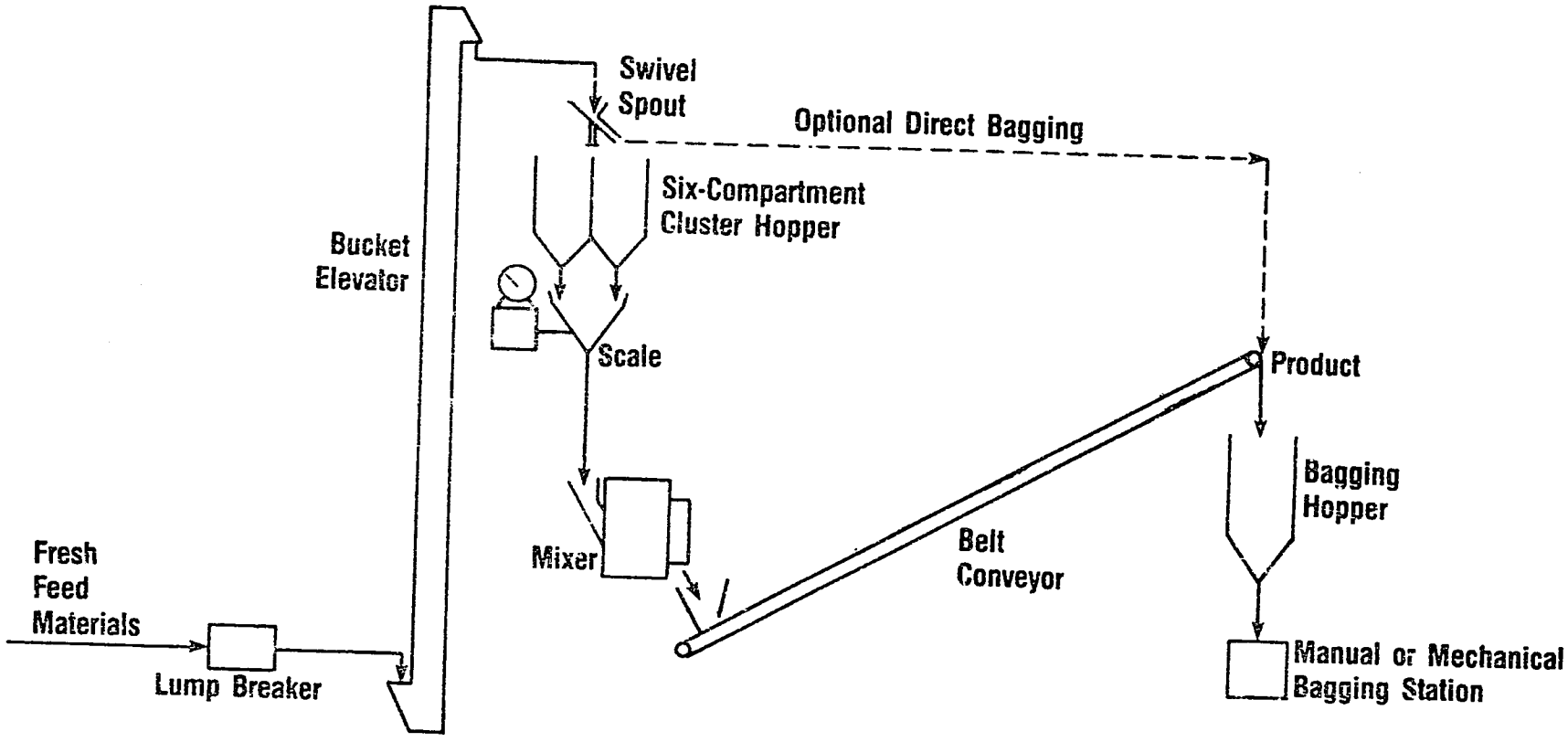


Figure III-9. Process Flow Diagram—Fertilizer Bulk-Blending Plant.

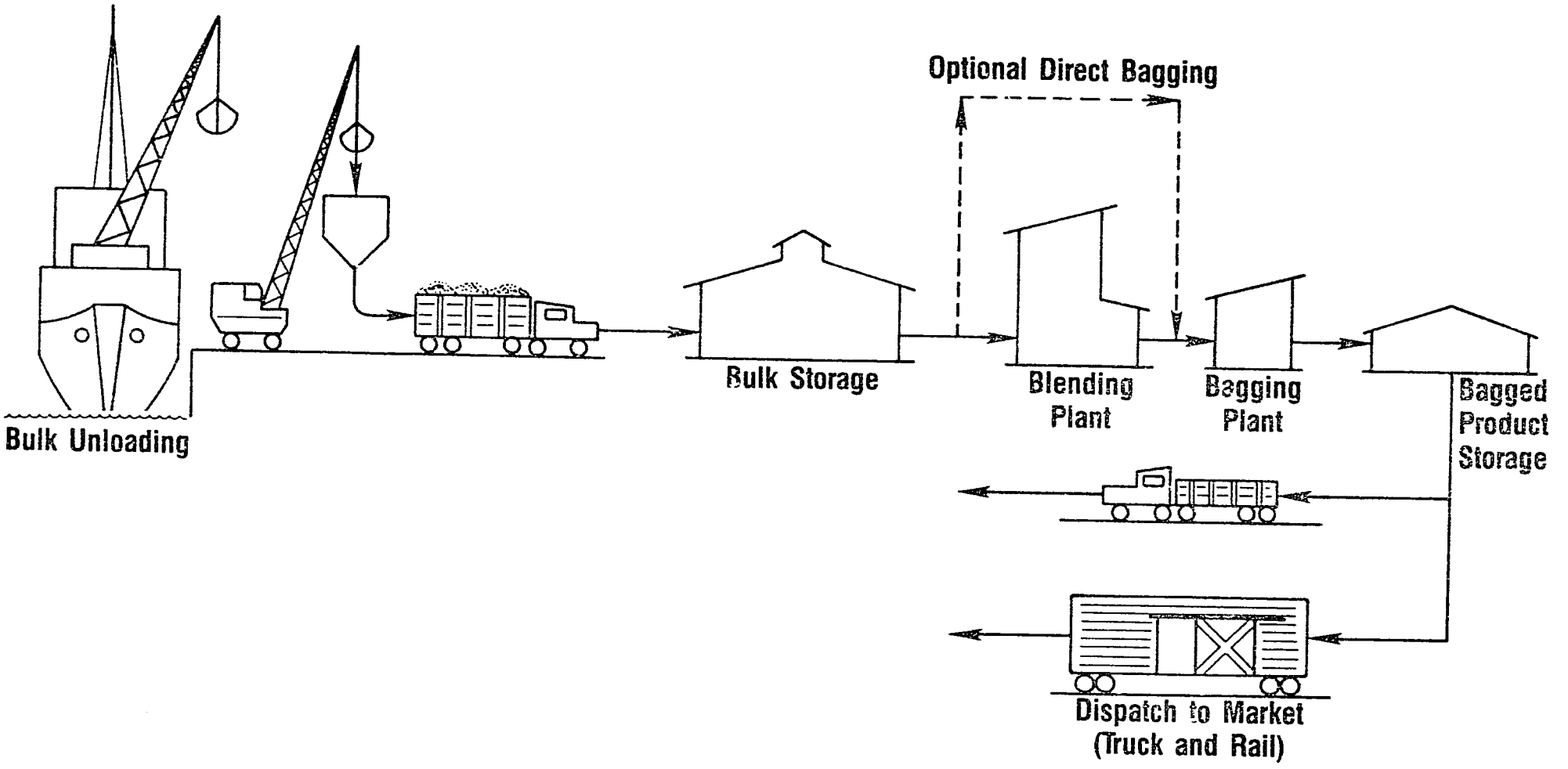


Figure III-10. Proposed Fertilizer Bulk-Blending and Bagging System.

coloring agents, or conditioners (to minimize caking) can also be added during the mixing step.

For this study, either manual or mechanical bagging is assumed. The manual bagging system consists of portable bagging hoppers that are filled by positioning a swivel spout over the appropriate hopper. The hoppers are equipped with internal baffle assemblies designed to minimize segregation of the bulk-blend components. Portable platform scales are located beneath each hopper and the operator fills plastic-lined, open mouth-type bags (usually 50 kg) by operating a manual discharge gate (filling spout) while observing the platform scale beam balance indicator. The filled bags are closed by first tying the plastic liner (usually polyethylene) with a rubber band or loop-type, plastic-coated wire tie. The outer bag (jacket), usually made of woven polypropylene, is stitched closed by using a hand-held electric sewing machine. This type of bagging is widely used in many developing countries and is an effective alternative to mechanical bagging, especially if skilled labor for maintenance is relatively expensive. One manual bagging station, as described above, served by five workers (bag filler, offbearer and plastic liner closer, sewer, and two helpers) can routinely bag and palletize at a rate of about 5 mtph (100 50-kg bags).

An alternative to manual bagging is a mechanical bagging operation. The main difference between manual and mechanical bagging is that with mechanical bagging the weighing operation is performed with an automatic weighing unit (mechanical or electronic) instead of the previously described manually operated filling spout and platform scale units. Although mechanical bagging units are reported by the manufacturers of such equipment to operate at rates of about 50 mtph (1,000 50-kg bags/h), in practice an average rate of about 25 mtph (500 50-kg bags/h) is more realistic. When a woven outer bag and a plastic inner bag are used, proper sealing of the two bags limits the capacity of any type of bagging operation. The net result is that either system (manual or mechanical) requires about the same labor per metric ton of product. The mechanical system may appear to be more cost effective, but in fact, it is usually more costly because of the larger investment and extra maintenance.

The envisioned bulk-blending and bagging facility would be located within an enclosed, ventilated structure (process plant building). The structural steel required to support the bulk-blending machinery would also serve as the major structural supports and framing for the building. Because of the corrosive nature of the fertilizer materials, all mild steel components (machinery,

structural steel, work platform, and related installations) should be sandblasted and then coated with a corrosion-resistant coating system.

Except for the concrete pit (about 3 m deep) required for the raw material lump breaker and bucket elevator systems, all equipment would be located at or above ground level. The pit is preferred to facilitate easy charging of material into the lump breaker by use of payloaders, dump carts, or wheelbarrows. The process plant building should be covered with corrugated mineral composite sheeting. Wood or reinforced plastic sheeting would be an acceptable alternative, but metal (steel or aluminum) sheeting should not be used because of its poor resistance to the corrosive fertilizer salts.

Plant Capacity

Bulk Blending--The proposed bulk blending plant, using a 5-mt batch-type mixer, will have a maximum capacity of about 40 mtph (about 600 mtpd assuming 16 h of actual operation/day). This translates to an annual maximum capacity of about 180,000 mt assuming 300 16-h workdays. The actual capacity obtained is largely related to the number of raw materials in the blend. A blend containing only two materials can be prepared at a faster rate than a blend containing more materials. The mixing time for each blend is about the same regardless of the number of materials. However, the time required to weigh four materials, for example, is obviously more than what is required to weigh only two materials. For the purpose of this study, an annual capacity of 160,000 mt is assumed. This corresponds approximately to the projected fertilizer demand for 1995 (mid-term of projected plant life).

Bagging--Two bagging lines are proposed. Each bagging line would have a capacity of about 25 mtph for a total bagging capacity of 50 mtph (about 800 mtph assuming 16 h of actual operation/day). As previously mentioned, the bagging rate for a single line is usually limited to about 25 mtph (500 50-kg bags/h) because of the time required to properly seal the plastic inner liner and then stitch (sew) the outer jacket.

Storage--The proposed bulk blending and bagging plant will require about 20,000 mt (4,000 m^2) for bulk storage of raw materials and about 10,000 mt (5,000 m^2) for bagged product storage. A more detailed discussion of the storage requirements is presented in the section entitled "Cargo Size and Storage for Raw Materials."

Using Urea for Bulk Blending

The following discussion describes the technical and practical items that must be resolved before a fertilizer bulk blending strategy can be fully recommended and implemented.

NPK Grades and Formulation Restrictions--It is likely that most of the agronomic requirements can be met with three basic nutrient (N-P_2O_5-K_2O) ratios--2:1:1, 1:1:1, and 1:3:1. Examples of typical grades with these nutrient ratios are 20-10-10, 17-17-17, and 10-30-10, respectively. The 20-10-10 grade is already being used, and the 17-17-17 is a more concentrated version of the 15-15-15 fertilizer now being used. The 10-30-10 is proposed as a new grade designed to deliver a maximum basal dose of phosphate (refer to Sections I and II). All three grades can be modified, if needed, to supply the optimum level of agronomic sulfur and boron. Although bulk blending of these recommended NPK grades is possible, it is not preferred under Cameroon conditions because urea is required (about 22% in the 20-10-10 formulation and about 15% in the 17-17-17 formulation). The 10-30-10 can be bulk blended without using urea. The use of urea for bulk blending in Cameroon is not recommended until it can be demonstrated that (1) reliable and economic supplies of high-quality granular urea can be obtained and (2) the usual adverse effects (increased hygroscopicity and caking) caused by mixing urea with DAP, MAP, and KCl will not be a constraint to the use of such blends.

If urea is used in the NPK blends, it is likely that the quality of the blended product will be substandard for two reasons. First, most internationally traded urea is in the form of prills (about 1-1.5 mm particle size) that are much smaller in size than the other granular ingredients (DAP, MAP, and KCl). Also, prills by nature are structurally relatively weak; therefore, the material is likely to contain relatively large quantities of minus 1-mm material (fines). The small size of the urea leads to segregation during handling and distribution. This, in turn, may lead to lack of uniform application and unreliable agronomic response. Second, the presence of urea in a blend causes the mixture to become more hygroscopic. This, together with the presence of fine material, usually causes caking. The tendency for caking is expected to be especially acute in Cameroon where relative humidity is high and where long-term storage of bagged product is required because of the nature of the fertilizer procurement, distribution, and use systems. These constraints, although minimized with adoption of the recommended new fertilizer supply and marketing system, are not expected to disappear.

A Practical Bulk-Blending Alternative--An alternative designed to overcome the adverse effects of using urea in the proposed bulk-blended fertilizers is to prepare a family of bulk-blended base materials containing little or no urea. These low-urea or urea-free bases would exhibit good physical and compatibility characteristics and would avoid most of the previously mentioned problems of segregation and caking. The bulk-blended base grades (designed primarily for food crops and cotton) would contain the appropriate amount of P_2O_5, K_2O, S, and B. However, because little or no urea is used in the blends, the nitrogen level in the base grades may be less than what is required for obtaining maximum yields. This would be overcome by adding nitrogen (in the form of urea) to the crop as a topdressing on an as-needed basis depending upon weather conditions, market prices, and other farm-level factors. In all cases the base products would contain sufficient nitrogen for starting the crop. If additional nitrogen or potassium was needed, it would be added to the established crop by topdressing with urea and potash. The recommended bulk-blended bases are shown in Table III-9.

With this system, the bulk-blended base grades would be manufactured, bagged, and dispatched from the proposed Douala factory (factory location discussed later). Likewise, urea and potash (for use as a straight material or for topdressing) and imported NPK compounds (20-10-10 coffee fertilizer, for example) would be received in bulk, bagged, and dispatched through the same factory. From an economic viewpoint (economy of scale), the total tonnage (NPK base grades plus straight materials) should pass through one factory, thus decreasing the unit cost through the optimum use of the facilities and personnel. However, the practical considerations and implications (competition, reliability, and cost) of single or multiple supply sources must be more fully evaluated before settling on a fixed number of suppliers (factories). In the early years of operation a total annual throughput (NPK bulk blends plus urea, potash, imported compounds, and other straight materials) of about 80,000 mt is expected. This would be equivalent to a capacity utilization of about 50% for the proposed factory. The throughput could increase to about 160,000 mtpy (100% capacity utilization) as the market develops. Relatively concentrated (high analysis) products are proposed in the new production and marketing system. Therefore, the growth in product tons will be less than what is estimated with the existing lower analysis materials. In 1991 it is expected that about 110,000 mtpy of products will be required for use on coffee and food crops. An additional

Table III-9. Composition of Recommended Bulk-Blended Fertilizers[a]

Bulk Blend	Use	Composition							
		Ammonium Sulfate	Urea	Monoammonium Phosphate	Diammonium Phosphate	Potassium Chloride	Micronutrient (Boron, 66% B)	Conditioner	Total
		(kg/mt)							
10-30-10-5S	General purpose food crops (with sulfur)	209	-	587	-	174	-	30	1,000
12-36-12	General purpose food crops (without sulfur)	-	-	215	551	204	-	30	1,000
13-26-13-5S-1B	Cotton (humid region)	209	-	138	411	217	16	9	1,000
19-19-10-5S-1B	Cotton (dry region)	209	166	-	418	170	16	21	1,000

a. If additional nitrogen is required, it would be added by topdressing with urea.

Source: IFDC.

44,000 mt is estimated for use on cotton, for a total of about 154,000 mt. Of this amount about 36% (about 56,000 mt) would be blended; the remainder would be 20-10-10 and straight materials that would be imported in bulk and only bagged.

Raw Material Supply

A major constraint to producing high-quality, nonsegregating bulk blends is the lack of readily available granular raw materials that are closely matched with respect to particle size and particle size distribution. If the individual ingredients differ significantly in particle size distribution, the blended materials will tend to segregate and the product will be quite variable in analysis from bag to bag thus leading to erratic agronomic performance.

In the proposed bulk-blending scheme, granular AS, DAP, MAP, and KCl will be needed. Since the urea will be applied separately as a topdressing (with the exception of 19-19-10-5S-1B for cotton), prilled urea will be adequate although a granular material is preferred because it is likely to cake less and arrive at the farm level in a more useful (easy to apply) condition. Of the granular materials required, AS will be the most difficult to obtain because it is not widely produced in granular form. The production of granular MAP is increasing, and this product should not be difficult to obtain. Granular DAP and KCl are widely available and are expected to present the least difficulty in procurement. Commercial-scale quantities of granular urea are currently produced in the Netherlands, New Zealand, Canada, Trinidad, Malaysia, and the United States. However, the large majority of urea traded internationally is the prilled variety, not granular. Therefore, in the short-term, a bulk-blending operation based on the use of granular urea is not advised until reliable supplies of granular urea at an economic price can be ensured. Of course, construction of a granular urea production unit in Cameroon (if such production is feasible) would remove this constraint. Furthermore, as previously stated, the use of urea (prilled or granular) in bulk blends tends to lower the physical quality of the product because of an increased tendency toward hygroscopicity and caking.

In addition to the N, P_2O_5, and K_2O nutrient sources, a source of supply of boron and conditioning dust is also needed. The required particle size specifications for the raw materials normally used for bulk blending, including boron and conditioning dust, are shown in Tables III-10 and III-11.

Table III-10. Typical Particle Size Specifications of Commercially Available Granular Materials Used for Bulk Blending

Granular Material	Particle Size, Cumulative Percent Retained, Tyler Mesh				
	+6 (3.35 mm)	+8 (2.36 mm)	+10 (1.70 mm)	+14 (1.18 mm)	+20 (0.85 mm)
Urea, 46% N	1	50	96	99	99
Ammonium sulfate (AS), 21% N	0	2	40	91	99
Ammonium nitrate (AN), 33.5% N	1	36	90	98	99
Monoammonium phosphate (MAP), 11% N, 52% P_2O_5	2	34	87	96	99
Diammonium phosphate (DAP), 18% N, 46% P_2O_5	2	34	87	96	99
Triple superphosphate (TSP), 46% P_2O_5	1	20	81	97	99
Potassium chloride (KCl), 60% K_2O	3	40	87	98	99
Sulfate of potash (SOP), 50% K_2O	2	20	60	90	97
Sulfate of potash magnesia, 22% K_2O, 18% MgO	2	23	57	78	85

Source: Manufacturers' product data sheets and IFDC.

Table III-11. Typical Specifications for Commercially Available Boron Compounds and Conditioning Dust

Boron Compounds

Material	Typical Composition B_2O_3	Typical Composition B	Typical Particle Size
	(%)	(%)	
Fercilizer borate (granular)[a]	46	14	97% between minus 6 plus 14-mesh (1.18-3.35 mm)
Solubor (powder)[a]	66	20	92% minus 200-mesh (0.075 mm)

Conditioning Dust

Material	Typical Composition[b] Al_2O_3	SiO_2	$CaCO_3$	Impurities	Typical Partical Size[b]
	(%)				
Kaolin clay	40	55	-	5	90% minus 10 μm
Diatomaceous earth (kieselguhr)	-	85	-	15	90% minus 20 μm
Chalk	-	-	90-100	-	100% minus 45 μm

a. Trade names of United States Borax & Chemical Corporation (U.S. Borax).
b. These specifications may vary widely depending upon source of material. Minimum particle size is most important criterion.

Source: Manufacturers' product data sheets and IFDC.

Production Guidelines and Precautions for Bulk Blending

Bulk-blending technology is relatively simple in principle, but field experience clearly indicates that it is subject to several restrictions. Customer dissatisfaction and the general collapse of a bulk-blending marketing strategy may occur if the following production guidelines and precautions are not observed.

1. Raw materials should be closely matched in particle size. If small amounts of micronutrient compounds are required (such as boron), they should be in the form of a fine powder to obtain good distribution and uniform adhesion to the granules.
2. Raw materials should be chemically compatible and not inclined to react with each other. A small amount of clay or other conditioner should be added as insurance against caking during storage.
3. Careful attention must be paid to weighing and mixing the components of the blend to ensure the proper nutrient ratio and uniform distribution of nutrients within the blend.
4. Transportation and storage systems for blended products must be designed to minimize post production segregation of the components of the blend.

A discussion of each of these factors follows.

Close Matching of Particle Sizes--As previously shown (Table III-10), most commercially available granular fertilizer materials used today for bulk blending are in the size range of minus 6- plus 16-mesh (Tyler), or about 1-3 mm. Raw materials in the size range of minus 6- plus 16-mesh (Tyler) will not automatically yield high-quality blends that will not segregate. The uniform distribution of the particle size of each ingredient within these limits is also important.

Powdered micronutrients are preferred. However, if the micronutrient compounds account for more than about 5% of the formula weight, granular micronutrient compounds should be used because it is difficult in most cases to make a large amount of powder adhere to the granules. Boron in a powdered form is recommended for the Cameroon cotton fertilizer because the equivalent of only about 1% B is needed. A small amount (about 0.2%) of used motor oil is also useful in helping to uniformly bind the powdered boron to the fertilizer granules.

The optimum method for applying boron to the crop would be to combine it in a liquid along with the application of insecticides or herbicides, thus avoiding the problems of maintaining a homogeneous mixture of the boron powder with the granular blend ingredients.

Chemical Compatibility--Some mixtures of granular materials used for bulk blending react with each other to form a wet, sticky, or lumpy mass. The most notable mixtures that are usually considered noncompatible because of their tendency to react are listed below.

1. Urea Plus Ammonium Nitrate: Urea in contact with ammonium nitrate (or compound fertilizers containing ammonium nitrate such as 20-10-10) in the presence of atmospheric moisture quickly becomes wet. The critical relative humidity (CRH) of the mixture is only about 18%. The CRH of a fertilizer material or mixture is defined as the atmospheric relative humidity level at which the fertilizer will begin to absorb moisture from the atmosphere. This absorption of atmospheric moisture is usually followed by wetting and caking of the fertilizer. In many cases the mixture will become wet even without exposure to the atmosphere, because of the small amount of moisture that is normally present in the urea and ammonium nitrate. For these reasons, blending of urea with ammonium nitrate should be avoided completely. Even storage of the two materials in adjacent areas should be avoided unless precautions are taken to prevent cross-contamination.
2. Urea Plus Superphosphates: Blending of urea with unammoniated normal or triple superphosphate can result in a chemical reaction that causes wetting. Urea tends to react with monocalcium phosphate monohydrate, the main constituent of superphosphate. This reaction releases water of hydration from the superphosphate. The released water forms a saturated solution of soluble reaction products that cause stickiness and caking. Not all superphosphates are highly reactive in this respect; some products with very low moisture contents react slowly. Some blending plants are reported to be operating successfully with urea-superphosphate blends, but blending of these materials should be carried out only after test batches have been made. If bagging is planned, the possibility of reaction and caking is greater because of the usually longer storage and contact time.
3. Urea Plus Ammonium Phosphate: Urea is usually very compatible with DAP. However, there is a possibility for unwanted reactions to occur between urea and MAP especially if the bulk blend is stored for a long period of time in bags. Under some conditions ammonia from the basic urea may react slowly with the more acidic MAP to form ammonium phosphate salt bridges between the granules of urea and MAP. Under normal conditions, using good-quality urea and MAP, caking is not expected to occur, but it is advisable

to test the compatibility of urea/MAP mixtures under actual field storage conditions to identify any major long-term problems with such mixtures.

4. Diammonium Phosphate Plus Superphosphate: When diammonium phosphate is mixed with unammoniated superphosphates, a reaction can occur in which ammonia is released from the diammonium phosphate and absorbed by the superphosphate. Results of the reaction are (1) water of hydration is released from the superphosphate, (2) ammonium phosphate crystals form intergranule caking bonds, and (3) the water solubility of the phosphate is decreased because of conversion of monocalcium phosphate to dicalcium phosphate. These reactions occur rather slowly and usually do not interfere if the blend is handled in bulk, but bagging and extended storage of such blends are not recommended. Ammoniation of the superphosphate prior to blending usually makes it unreactive with diammonium phosphate and eliminates the problem of incompatibility. The expected compatibility of several bulk-blended materials is shown in Figure III-11.

Conditioning--For extra protection against caking of blended products during storage, a small amount (0.5%-2%) of conditioning dust should be added during the blending operation. Conditioning dust is recommended because it coats the granules and protects them to some extent and thus tends to retard unwanted chemical reactions. The dust also weakens the bonds (salt bridges) between granules if there is a tendency for caking caused by slow chemical reaction between the ingredients during storage. The addition of a small amount (less than 0.5%) of waste motor oil or heavy fuel oil is also an effective method for ensuring that the conditioning dust adheres to the fertilizer granules. As previously mentioned, the oil coating is also useful for bonding powdered micronutrients to the bulk blend granules.

Weighing and Mixing--In addition to requiring ingredients that are closely matched with respect to particle size and chemical compatibility, the production of high-quality blends can be obtained only if careful attention is given to weighing and mixing the ingredients used in the blend.

The most accurate and trouble-free method for obtaining the correct weight of each ingredient is to use a batch-type weighing system. The batch-type weighing process can consist of a very simple ground-mounted weigh hopper that is fed with a tractor-type front end loader, or it can consist of overhead storage bins that manually or automatically feed materials to a batch-type weighing unit. Regardless of the degree of automation used, the principle of this method

	Ammonium Nitrate or Ammonium Nitrate-Containing Materials	Urea	Ammonium Sulfate	Triple Superphosphate	Single Superphosphate	Diammonium Phosphate	Monoammonium Phosphate	Potassium Chloride	Potassium Sulfate
Ammonium Nitrate or Ammonium Nitrate-Containing Materials		X	OK	OK	OK	OK	OK	OK	OK
Urea	X		OK	L	L	OK	OK	OK	OK
Ammonium Sulfate	OK	OK		OK	OK	OK	OK	OK	OK
Triple Superphosphate	OK	L	OK		OK	L	OK	OK	OK
Single Superphosphate	OK	L	OK	OK		L	OK	OK	OK
Diammonium Phosphate	OK	OK	OK	L	L		OK	OK	OK
Monoammonium Phosphate	OK	OK	OK	OK	OK	OK		OK	OK
Potassium Chloride	OK	OK	OK	OK	OK	OK	OK		OK
Potassium Sulfate	OK	OK	OK	OK	OK	OK	OK	OK	

X = Incompatible
L = Limited Compatibility (refer to text)
OK = Compatible

Source: Tennessee Valley Authority.

Figure III-11. Chemical Compatibility of Bulk-Blend Materials.

is the same (each ingredient of the batch is weighed separately and precisely before or as it is charged into the mixer).

Continuous weigh systems utilizing a weighbelt are sometimes used. Under most circumstances continuous weighing systems require constant checking and calibration to ensure reasonable accuracy. For this reason such systems are not as reliable as the batch method.

Some bulk-blending systems do not use a scale to weigh the materials. Instead, the system relies on the volumetric flow of each material as an indirect method for obtaining the desired weight of material. Such volumetric proportioning systems are not recommended for bulk blending because there are too many uncontrollable variables that cause the bulk density and, consequently, the weight of a certain volume of material to change. These changes in volume and weight cause wide fluctuations in the nutrient ratio and analysis of the product.

After the ingredients of a blend have been accurately weighed, they must be thoroughly mixed to produce a homogeneous blend. The most frequently used type of mixer is the rotary drum. Excellent mixing can be obtained with this type of unit. Usually a mixing time of about 3-4 minutes is sufficient to obtain a homogeneous blend. This type of mixer is also well suited for mixing and dispersing small amounts of micronutrients, conditioners (clay or oil), or other additives into blends.

A relatively new variation of the standard rotary-drum mixer is the twin-shell or vee-type mixer mounted on a scale. This arrangement combines weighing and mixing in one machine, thus simplifying the system and shortening the cycle time per batch. Approximately 20 of these units are operating in the United States and Canada, and about 5 are in service in Central America. This type of mixer design and arrangement appears to have all the advantages of the standard rotary-drum mixer.

There are other types of mechanical mixers, such as paddle- or pugmill-type mixers, ribbon blenders, and modified screw conveyor-type mixers. Although these types of mixers may be adequate, they usually are inferior to the rotary-drum or rotary twin-shell units because they tend to grind the materials and produce fines that may cause segregation and caking of the product. Also, they are not as well suited for mixing small amounts of micronutrients and other additives into the blend. A modified paddle-type mixer was recently developed by a United States fertilizer equipment company. This mixer design appears to have overcome most of the mechanical design and operating problems normally associated with paddle-type mixers.

Handling Bulk Blends After Mixing--After bulk-blended products are discharged from the mixer, certain precautions must be taken during handling to prevent segregation of the individual conponents of the blend. As mentioned previously, the most important factor in preventing segregation is to use closely matched (with respect to particle size) ingredients. Even when this is done, it is wise to minimize the number of times the blended product is handled before it is bagged or loaded for bulk transport or broadcasting.

If the product is going to be bagged immediately after it is mixed, the bagging hopper should be equipped with an "egg crate" vertical partition assembly. This device will decrease the possibility of segregation which could cause a large difference in the analysis of the product from bag to bag, especially if poorly matched materials happen to be used.

A Need for Judgment

The relative importance of adhering to the previously described production guidelines and precautions (including the use of urea) depends largely upon the requirements of the fertilizer distribution system and the farmer. To illustrate, in the United States cornbelt, most of the solid fertilizer used is in the form of bulk blends. In most cases the blends are prepared and immediately (within hours) broadcast on the farmer's fields; bags are seldom used. With this type of high-speed bulk-handling operation, chemical compatibility restrictions are not too important and ammonium nitrate, urea, superphosphate, and ammonium phosphate materials are frequently blended together without serious problems. However, good particle size matching of the raw materials is still very important to minimize segregation during bulk handling, drilling, and broadcasting.

On the other hand, bulk blends that are bagged and stored for long periods (often more than 6 months in many developing countries) must be prepared with careful attention to the chemical compatibility of the ingredients to minimize the risk of caking. Likewise, the effect of particle size distribution and especially the influence of fines (increased surface area and chemical reactivity) become increasingly important with prolonged storage.

Customer needs also have a great influence upon the importance of bulk-blending production requirements. For example, aerial application of fertilizer is often the most efficient and cost effective method for some large oil palm, rubber, or sugarcane estates. With aerial application large (3-6 mm), homogeneous granules give best results because wind drift and segregation are

minimized and good penetration through the foliage is achieved. However, the smaller growers, who utilize mostly hand labor, find bulk blends satisfactory even when the blends have relatively poor physical properties. Blends of prilled urea, ground phosphate rock, and standard (nongranular) potash are often used. Multiple application (by hand) of these blends together with careful management by the farmer results in a very effective fertilizer supply system.

Cargo Size and Storage for Raw Materials

A possible constraint to bulk blending in Cameroon is related to the raw material logistics. The four major raw materials for bulk blending (AS, DAP, MAP, and KCl) plus imported NPK compounds and straight materials (especially urea) amounting to a total of about 154,000 mtpy (1991 consumption estimate) must be available in the correct proportion for the system to work efficiently. About 38% (about 59,000 mtpy) of the total would be imported 20-10-10 for use on coffee, about 26% (about 40,000 mtpy) would be urea for topdressing, and the remaining 36% (about 55,000 mtpy) would be divided between AS, DAP, MAP, and KCl. About 71% (110,000 mt) of the total estimated 1991 consumption of about 154,000 mt would be used on coffee and food crops; the remainder (about 44,000 mt) would be used on cotton. A summary of the estimated fertilizer material requirements for 1991 is shown in Table III-12.

The existing port facilities are designed to handle relatively small ships. For the purpose of this study, 10,000-mt cargos are considered maximum with lots of 5,000 mt preferred. Cargos of about 5,000 mt are likely to prevail during the early years of the proposed project. Therefore, in a typical year (1991 for example) the following shipping schedule would have to be maintained to achieve an annual throughput (production) of 154,000 mt according to the above product/raw material distribution.

Product or Raw Material	Total Material Required (mt x 1,000)	Number of 5,000-mt Cargos/year
20-10-10	59	12
Urea	40	8
DAP	18	4
AS	15	3
KCl	10	2
MAP	10	2
Boron and conditioner	2	-
TOTAL	154	31

Table III-12. Estimated Fertilizer Material Requirements (Imports)--5th Year (1991) Projection Using New Fertilizer Supply and Marketing Plan

Crop and Fertilizer	20-10-10 (Compound)	Ammonium Sulfate (AS)	Urea	Monoammonium Phosphate (MAP)	Diammonium Phosphate (DAP)	Potassium Chloride (KCl)	Boron Source	Conditioner	Total
	(mt x 1,000)								
Coffee									
20-10-10 compound[a]	59.0	-	-	-	-	-	-	-	59.0
Food Crops									
10-30-10-5S bulk blend[b]	-	2.5	-	7.0	-	2.1	-	0.4	12.0
Urea topdressing	-	-	36.0	-	-	-	-	-	36.0
Ammonium sulfate topdressing	-	3.0	-	-	-	-	-	-	3.0
Subtotal (coffee and food crops)	59.0	5.5	36.0	7.0	-	2.1	-	0.4	110.0
Cotton									
13-26-13-5S-1B bulk blend[b] (humid region)	-	4.6	-	3.0	9.0	4.8	0.4	0.2	22.0
19-19-10-5S-1B bulk blend[b] (dry region)	-	4.6	3.7	-	9.2	3.7	0.4	0.4	22.0
Subtotal (cotton)	-	9.2	3.7	3.0	18.2	8.5	0.8	0.6	44.0
TOTAL (all crops)	59.0	14.7	39.7	10.0	18.2	10.6	0.8	1.0	154.0

a. Initially 20-10-10 will be imported. It may be replaced later with a bulk-blended product.
b. Quantities of raw materials required are listed.

Source: IFDC.

Assuming uniform operation of the bulk-blending and bagging unit throughout the year (12 months at about 13,000 mt/month), an average of about three ships (assuming 5,000 mt each) would have to discharge each month.

Because of the importance of maintaining the correct raw material balance, a relatively large buffer stock will be needed. The large buffer stock of raw materials will provide insurance against delays caused (1) by problems in procurement and shipping and (2) by congestion at the port as a result of delays in unloading because of rain and other factors such as equipment failures, unavailability of trucks, and labor shortages or work stoppages. In the proposed system, a 15,000-mt capacity bulk storage building is used for the four bulk raw materials (DAP, MAP, AS, and KCl) and imported 20-10-10. An additional 5,000 mt of bulk storage is proposed for urea and other straight materials such as potash and kieserite. Therefore the total bulk storage will amount to 20,000 mt. If we assume a total annual throughput of 154,000 mt, a turnover factor of about 11 will be needed, assuming that the average utilization (fill) of the bulk storage capacity is about 70%. This relatively rapid turnover (about once per month) will be beneficial in maintaining fresh, free-flowing materials.

The bulk storage building should be constructed to minimize the adverse effects of the high ambient relative humidity (RH). The building should be tightly closed to take maximum advantage of solar heating in decreasing the internal RH. For example, if the inside temperature is elevated to about 42°C, the RH of the air will decrease to about 55% assuming it was at 90% RH at an ambient temperature of 32°C. A 55% RH inside the bulk storage building will ensure that the materials (including 20-10-10 and urea) will not absorb a significant amount of moisture. The relative humidity levels at which a number of fertilizer materials and mixtures of materials will begin to absorb moisture from the atmosphere (referred to as the CRH of the material) are shown in Table III-13.

If the inside temperature of the bulk storage building is too high for worker comfort, an air-chilling system will be needed. With such a system a make-up stream of air is chilled to remove a portion of the humidity (moisture) and then is reheated (to decrease the RH) either by the solar heat load within the building or by an auxiliary steam heater if the solar heat load is insufficient. In this particular case, it is likely that an air chiller/reheat system may be needed only for the 20-10-10 and urea portions of the bulk storage building. The other materials are less hygroscopic than 20-10-10 and urea and are expected to remain in good condition provided the building is kept reasonably

Table III-13. Approximate Critical Relative Humidity (CHR) of Fertilizers and Fertilizer Mixtures, Percent Relative Humidity at 30°C

	Material alone	Triple Superphosphate	20-20-0 Nitric Phosphate	Urea	Calcium Nitrate	Ammonium Nitrate	Ammonium Sulfate	Ammonium Chloride	Diammonium Phosphate	Potassium Chloride	Potassium Nitrate	Monoammonium Phosphate	Potassium Sulfate	20-10-10 Nitrate-Based NPK	17-17-17 Nitrate-Based NPK	13-13-13 Ammonium Sulfate-Based NPK	28-28-0 Urea Ammonium Phosphate	35-17-0 Urea Ammonium Phosphate	26-0-0 Ammonium Nitrate-Limestone
Triple Superphosphate	90	-	50	60	45	50	70	65	75	65	>80	>80	75	50	60	65	60	55	55
20-20-0 Nitric Phosphate	55	50	-	<45	<45	55	55	55	55	55	55	55	55	55	55	55	<45	<45	55
Urea	70	60	<45	-	<45	<45	55	55	50	50	65	55	50	<45	<45	45	50	55	<45
Calcium Nitrate	45	45	<45	<45	-	<45	60	<45	60	<45	<45	50	75	<45	<45	55	50	55	<45
Ammonium Nitrate	55	50	55	<45	<45	-	55	50	55	55	55	55	55	50	50	55	<45	<45	55
Ammonium Sulfate	75	70	55	55	60	55	-	70	70	70	65	70	70	55	55	70	50	50	55
Ammonium Chloride	75	65	55	55	<45	50	70	-	65	65	65	65	70	55	55	70	50	50	50
Diammonium Phosphate	80	75	55	50	60	55	70	65	-	65	65	70	65	55	55	65	50	50	55
Potassium Chloride	80	65	55	50	<45	55	70	65	65	-	70	65	75	60	55	70	45	45	55
Potassium Nitrate	90	>80	55	65	<45	55	65	65	65	70	-	70	75	55	55	60	50	55	60
Monoammonium Phosphate	90	>80	55	55	50	55	70	65	70	65	70	-	65	55	55	65	50	55	60
Potassium Sulfate	95	75	55	50	75	55	70	70	65	75	75	65	-	55	55	70	45	<45	60
20-10-10 Nitrate-Based NPK	55	50	55	<45	<45	50	55	55	55	60	55	55	55	-	-	-	<45	<45	50
17-17-17 Nitrate-Based NPK	55	60	55	<45	<45	50	55	55	55	55	55	55	55	-	-	-	<45	<45	50
13-13-13 Ammonium Sulfate-Based NPK	70	65	55	45	55	55	70	70	65	70	60	65	70	-	-	-	-	-	55
28-28-0 Urea Ammonium Phosphate	50	60	<45	50	50	<45	50	50	50	45	50	50	45	<45	<45	-	-	-	<45
35-17-0 Urea Ammonium Phosphate	55	55	<45	55	55	<45	50	50	50	45	55	55	<45	<45	<45	-	-	-	<45
26-0-0 Ammonium Nitrate-Limestone	55	55	55	<45	<45	55	55	50	55	55	60	60	60	50	50	55	<45	<45	-

Source: Tennessee Valley Authority and IFDC.

tight. It is especially important to keep the bulk storage building closed at night to minimize the "chimney effect" caused by warm air rising and escaping from the top of the building and in doing so drawing in cool, humid night air through open doors, vents, and cracks. The building must also be well above the natural grade to avoid the entrance of surface (runoff) water.

Plant Operation (Continuous Versus Intermittent)

Fertilizer is extremely corrosive to machinery. Idle machinery quickly deteriorates as a result of the combined corrosive effect of fertilizer and the humid ambient conditions (typical of Douala). Therefore it is important to maintain a reasonably steady mode of operation. Steady operation, resulting in a lower humidity within the plant because of a constant flow of dry and fresh materials, and a slightly elevated internal building temperature, combined with a diligent lubrication and equipment maintenance program, are essential to the success of the proposed fertilizer bulk-blending and bagging scheme.

Intermittent operation of the proposed plant--for example, a 6-month period only during the "dry" season--is not recommended and would be costly for the following reasons:

1. The machinery would corrode and deteriorate rapidly during periods of nonoperation.
2. A skilled workforce would be difficult to maintain.
3. The raw material storage facilities would have to be excessively large.
4. The logistics of moving raw material and products away from the port and into the market area during a shorter (6 month) timeframe would be more difficult.

Since bulk blending is a batch-type operation, it is easy to increase capacity merely by operating more hours per day provided sufficient raw materials are available and the offtake (transportation) capacity can cope with a cyclic offtake pattern. In the proposed system steady operation throughout the year is recommended. In the early years of operation about 240 8-hour workdays will be required to process (bulk blend and/or bag) about 75,000 mtpy of fertilizer. As the market grows, the length of the workday can be increased. A total annual production of about 160,000 mt (bulk blends, compound 20-10-10, and straight materials) can be processed during 240 16-hour workdays. If necessary, the length of the workday can be further increased to meet peak periods of demand.

Plant Location

A discussion of the factors important to selecting the site for the proposed bulk-blending and bagging plant follows. A preliminary site recommendation is also given.

The Douala/Bonaberi port area appears to be the most logical choice for this facility for the following reasons:

1. Dock facilities are available at the Douala and Bonaberi ports. It is also quite likely that an additional dock or jetty specific for fertilizer could be constructed in the future if congestion at the existing dock facilities occurred. The "fertilizer jetty" could be served using offshore unloading into lighters or barges that could deliver the bulk or bagged fertilizer material to a shallow water jetty. This method (offshore unloading) would eliminate the need for expanding the deepwater (8 m) portion of the existing port and would add considerable flexibility to the existing Douala/Bonaberi ports.
2. The existing road and railroad system is well developed for movement of product away from the Douala/Bonaberi area.
3. The site of the former SOCAME plant is suitable for the bulk-blending plant. This site, located adjacent to Bonaberi port, is about 3 km from the main Douala port. This site is now used by FONADER for storage of its fertilizers. In order to efficiently use this site, the old sulfuric acid, superphosphate, and granulation plants should be removed. The bulk-storage building (about 10,000-mt capacity) is basically very well constructed. However, the floor must be elevated (by filling and repaving) to eliminate drainage of water into the building. Also, the sidewalls and doors must be repaired to obtain maximum protection for the bulk fertilizer materials. A bulk material unloading and conveyor system must also be installed to efficiently utilize the capacity of the building and the proposed port-to-plant raw material transfer equipment (trucks).
4. The site owned by Agrichim near Bonaberi may also be acceptable. Some disadvantages of the Agrichim site are that it is too small (about 1.3 ha, 13,000 m^2) for the envisioned facility which requires about 9,000 m^2 for storage and it is about 10 km from the Douala port. The railroad is close to the Agrichim site; however, a spur would have to be extended to the plant site for optimum utilization of the railroad system. Existing

activities at the Agrichim site (production of pesticides) limit the available area for bulk blending to about 7,000 m^2. Since office facilities are already available at the site, the 7,000 m^2 would be adequate if the plant is operated on a relatively continuous basis at a lower annual throughput (about 80,000 mtpy) to decrease the required storage to about 5,000 m^2.

5. Other sites may be available in the Douala/Bonaberi area. Certain criteria are important in selecting a site. For example, it is important that a usable land area of about 2 ha (20,000 m^2) be available for storage buildings, bulk-blending and bagging facilities, office building, maintenance shop, and roadways. A railroad spur for dispatch of bagged product is also desired although trucking of products to a nearby railhead may be a suitable alternative.

It is recommended that no consideration be given to locating the proposed bulk-blending plant at a site nearer to the market area and away from Douala. This recommendation is made for the following reasons:

1. Efficient transport of bulk raw materials would be limited by the lack of sufficient trucks and railroad equipment to rapidly move bulk materials away from the port at a rate equivalent to a required ship discharge rate of 800 mtpd. This rate is needed to obtain reasonable ocean freight/port charges.
2. Management, operation, and maintenance of a bulk-blending facility remote from the populated area of Douala would likely be more difficult and less efficient.

In the future it may be feasible to locate a "satellite" bulk-blending and bagging plant in one or more key market areas. However, this should be done only after it has been clearly demonstrated that the above-mentioned contraints have been overcome.

Bagging Plant Outside of Port Boundary

This study indicates that the construction of a bulk-blending plant should be delayed until an improved marketing plan is implemented to ensure that the market is ready to receive the new (bulk-blended) products in sufficient quantity to make the operation of the plant technically and economically feasible. If the proposed new marketing plan develops as indicated, the bulk-blending plant would be installed during the second or third year of the project.

In anticipation of success of the proposed marketing plan and the need for bulk blending, the following stepwise construction project is recommended.

Step One--During the first 1-2 years of the project an integrated fertilizer bagging and bulk-blending factory should be engineered. However, only the bagging and associated storage facilities should be constructed. A diagram of the proposed complete system including (1) dockside unloading and transport equipment, (2) product storage, (3) bulk-blending plant, and (4) the bagging plant was previously shown in Figure III-10.

Step Two--When the market is sufficiently developed to justify bulk blending, the blending unit along with additional bulk storage capacity would be added. The stepwise construction of the project over a period of up to about 4 or 5 years is not expected to be more costly than building the entire unit initially. This is because improved capacity utilization (cost effectiveness) can be achieved by gradually increasing the capital investment, capacity, and product flexibility as the market demands.

It may also be possible to use the bagging plant to perform contract bagging of fertilizer or grain (assuming the unit is properly designed) for others. Such activities will be helpful in decreasing the cost that must be charged directly to the fertilizer bagging operation. It may also be possible to do additional bulk blending on a contract basis for specialized accounts such as estates or selected wholesalers.

Dockside Bagging

In the proposed scheme the bagging of bulk blends, compound 20-10-10, and straight materials (principally urea and potash) is done within the battery limits of the proposed factory. However, the dockside bagging of imported compounds and straight materials may also be considered an "emergency-type" alternative.

Although dockside bagging has certain advantages, it also has limitations. The most notable disadvantages specific to Cameroon (Douala port) are listed.

1. The equipment location and operation must be carefully coordinated with the port authority. This is expected to be difficult because of the small space between the water's edge and the transit sheds (about 100 m). This dock space is used as a primary roadway and transfer zone for ship discharging and loading and does not offer sufficient room for the bagging equipment.

2. Port congestion is unpredictable and may interfere with the dockside bagging operation which is relatively inflexible with respect to coordination with other port activities.
3. The dockside bagging operation would decrease the throughput of the proposed bulk-blending and bagging factory and therefore the cost of operation per metric ton of fertilizer would increase.
4. The investment in equipment for dockside bagging is relatively high (about US $125,000 per 25-mtph bagging line) and this equipment would probably be idle for long periods. At least two bagging lines (US $250,000) would be required to discharge a 5,000-mt ship in about 5 days.

It may be practical for the proposed bulk-blending and bagging plant to operate one dockside bagging unit to handle small shipments or to accommodate surges during peak periods of demand. Since these units are portable, a unit could be utilized more effectively in this manner than if it were operated by a separate organization and used solely for dockside bagging. Also, during periods of nonoperation at the dockside, the portable bagging unit could be used to bag materials at the factory such as urea, kieserite, or limestone. It may also be possible to bag nonfertilizer materials (grain, for example) on a contract basis to further improve the economics of the overall operation.

Production Economics for Bulk Blending and/or Bagging

Bulk Blending and Bagging

Fixed capital investment, conversion, and production cost estimates for bulk blending and bagging are shown in Tables III-14 through III-18. In addition to the technical components described above, other premises and assumptions are used in estimating the investment and production costs (Appendix M). A discussion of the major economic components follows.

Fixed Capital Investment--A total fixed capital investment of about US $4.4 million is estimated for the proposed facility (Table III-14). Warehouse facilities account for about 45% of this investment (US $1.2 million for 4,000 m^2 [20,000 mt] bulk and US $0.8 million for 5,000 m^2 [10,000 mt] bagged product storage). If the plant is built on a stepwise basis starting with only bulk material unloading and bagging, the total fixed capital investment, not including bulk blending and the required additional storage, would be about US $1.8 million (Table III-15).

Table III-14. Fixed Capital Investment Estimate for Bulk Blending and Bagging Plant

Premises

1. Cost basis: 1985 US$
2. Plant location: New site near Douala/Bonaberi port
3. Plant capacity data:

Blending	40 mtph (maximum)
Bagging	50 mtph
Bulk raw material storage	20,000 mt
Bagged product storage	10,000 mt

Item	Estimated Cost (US$ x 1,000)
Bulk-blending and bagging unit	500
Bulk warehouse including material unloading and conveyor system (4,000 m^2 x US $300/$m^2$)	1,200
Bagged product warehouse including pallets (5,000 m^2 x US $160/$m^2$)	800
Dockside mobile crane and portable discharge hoppers	200
Truck scale	70
Mobile equipment (3 payloaders and 3 forklifts)	300
Bulk transfer trucks (dump body), 4 units	320
Utility facilities	100
Laboratory and maintenance shop	60
Administration building and offices	80
Site development	200
Project management, preoperational, and startup expenses	200
Contingency (10%)	400
Total fixed investment	4,430

Source: IFDC.

Table III-15. Fixed Capital Investment Estimate--Bagging Plant Located Near Douala/Bonaberi Port

Premises

1. Cost basis: 1985 US$
2. Company owned/operated dockside unloading and transport equipment (mobile crane and dump trucks)
3. 10,000 mt maximum shipments
4. 800 mtpd discharge rate (40 mtph), ship's gear plus mobile crane
5. 12 months/year receiving pattern
6. 50 mtph bagging rate
7. 3,000 mt (600 m^2) bulk product storage
8. 2,000 mt (1,000 m^2) bagged product storage

Item	Cost (US$ x 1,000)
Dockside mobile crane and portable discharge hoppers	200
Bulk transfer trucks (dump body), 4 units	320
Bulk warehouse including material unloading and conveyor system	180
Bagged product warehouse including pallets	160
Bagging plant	280
Truck scale	70
Maintenance shop and equipment	50
Administration building and offices	80
Utility facilities	100
Site development	100
Project management	150
Contingency (10%)	150
Total	1,840

Source: IFDC.

Table III-16. Conversion Cost Estimate--Bulk Blending and Bagging Plant Located Near Douala/Bonaberi Port

Premises

1. Cost basis: 1985 US$
2. Fixed capital: $4.4 million (Table III-14)
3. Annual production at 100% capacity utilization:

NPK bulk blended product	100,000 mt
Straight products (bagging only)	60,000 mt
Total	160,000 mt

4. Working capital: $3.0 and $5.0 million for production at 50% and 100% capacity utilization, respectively
5. Annual interest on working capital: 13%

	Basis	Annual Cost 50% Capacity Utilization	Annual Cost 100% Capacity Utilization
		- - - (US$ x 1,000) - - -	
Fuel and electricity	US $2.0/mt	160	320
Bags	US $12.0/mt	960	1,920
Miscellaneous supplies	US $0.2/mt	16	32
Operating labor	US $0.5/mt	40	80
Supervision and maintenance labor	-	40	40
Maintenance materials	2% of US $4.4 mm	88	88
Insurance	1% of US $4.4 mm	44	44
Administration and general overhead	200% of labor and supervision	160	240
Fixed capital recovery	17.1% of US $4.4 mm	752	752
Interest on working capital	13% on 75% of working capital	292	488
Total annual conversion cost		2,552	3,928
Unit conversion cost, US $/mt			
Average for bulk blended NPK and straight products		31.9	24.5
Allocated cost, US $/mt			
Bulk blended NPK products		33.0	25.5
Straight products		30.0	23.0

Source: IFDC.

Table III-17. Conversion Cost Estimate--Bagging Plant Located Near Douala/ Bonaberi Port

Premises

1. Cost basis: 1985 US$
2. Fixed capital investment: US $1.8 million (Table III-15)
3. Annual production at 100% capacity utilization: 100,000 mt
4. Working capital: US $1.0 million
5. Annual interest on working capital: 13%

Item	Basis	Annual Cost (US$ x 1,000)
Truck drivers/crane operators	-	12
Bagging and warehouse labor	US $0.4/mt	40
Supervision and maintenance labor	-	20
Bags	US $12.0/mt	1,200
Maintenance material	3% of US $1.8 mm	54
Miscellaneous supplies	US $0.1/mt	10
Fuel and electricity	US $1.5/mt	150
Insurance	1% of US $1.8 mm	18
Administration and general overhead	200% of labor and supervision	144
Fixed capital recovery	17.1% of US $1.8 mm	308
Interest on working capital	13% of 75% of working capital	97
Total annual conversion cost		2,053
Unit conversion cost, US $/mt		20.5

Source: IFDC.

Table III-18. Estimated Production Cost for Bulk-Blended Granular Fertilizers[a]

Raw Material[b]	Cost (US $/mt)	General Purpose Food Crop With Sulfur, 10-30-10-5S: Raw Material Consumption (mt/mt product)	General Purpose Food Crop With Sulfur, 10-30-10-5S: Cost (US $/mt product)	General Purpose Food Crop Without Sulfur, 12-36-12: Raw Material Consumption (mt/mt product)	General Purpose Food Crop Without Sulfur, 12-36-12: Cost (US $/mt product)
Ammonium sulfate (21% N, 24% S)	148	0.209	30.9	-	-
Urea (46% N)	193	-	-	-	-
Monoammonium phosphate (11% N, 52% P_2O_5)	264	0.587	155.0	0.215	56.8
Diammonium phosphate (18% N, 46% P_2O_5)	259	-	-	0.551	142.7
Potassium chloride (60% K_2O)	154	0.174	26.8	0.204	31.4
Micronutrient (boron) (66% B)	743	-	-	-	-
Conditioner (clay/oil)	150	0.030	4.5	0.030	4.5
Subtotal (raw materials)		1.000	217.2	1.000	235.4
Conversion cost			25.5		25.5
Total production cost (product basis)			242.7[f] 250.2[g]		260.9[f] 268.4[g]

Raw Material[b]	Cost (US $/mt)	Humid Region Cotton 13-26-13-5S-1B: Raw Material Consumption (mt/mt product)	Humid Region Cotton 13-26-13-5S-1B: Cost (US $/mt product)	Dry Region Cotton 19-19-10-5S-1B: Raw Material Consumption (mt/mt product)	Dry Region Cotton 19-19-10-5S-1B: Cost (US $/mt product)
Ammonium sulfate (21% N, 24% S)	148	0.209	30.9	0.209	30.9
Urea (46% N)	193	-	-	0.166	32.0
Monoammonium phosphate (11% N, 52% P_2O_5)	264	0.138	36.4	-	-
Diammonium phosphate (18% N, 46% P_2O_5)	259	0.411	106.4	0.418	108.3
Potassium chloride (60% K_2O)	154	0.217	33.4	0.170	26.2
Micronutrient (boron) (66% B)	743	0.016	11.9	0.016	11.9
Conditioner (clay/oil)	150	0.009	1.4	0.021	3.2
Subtotal (raw materials)		1.000	220.4	1.000	212.5
Conversion cost			25.5		25.5
Total production cost (product basis)			245.9[f] 253.4[g]		238.0[f] 245.5[g]

(Continued)

Table III-18. Estimated Production Cost for Bulk-Blended Granular Fertilizers[a] (Continued)

Raw Material[b]	Cost (US $/mt)	Cotton 15-15-15-6S-1B Raw Material Consumption (mt/mt product)	Cotton 15-15-15-6S-1B Cost (US $/mt product)	Cotton 22-10-15-5S-1B Raw Material Consumption (mt/mt product)	Cotton 22-10-15-5S-1B Cost (US $/mt product)
Ammonium sulfate (21% N, 24% S)	148	0.250	37.0	0.209	30.9
Urea (46% N)	193	0.090	17.4	0.303	58.5
Monoammonium phosphate (11% N, 52% P_2O_5)	264	-	-	-	-
Diammonium phosphate (18% N, 46% P_2O_5)	259	0.331	85.7	0.218	56.5
Potassium chloride (60% K_2O)	154	0.254	39.1	0.250	38.5
Micronutrient (boron) (66% B)	743	0.016	11.9	0.016	11.9
Conditioner (clay/oil)	150	0.059	8.9	0.004	0.6
Subtotal (raw materials)		1.000	200.0	1.000	196.9
Conversion cost			25.5		25.5
Total production cost (product basis)			225.5[f] 233.0[g]		222.4[f] 229.9[g]

Raw Material[b]	Cost (US $/mt)	Coffee 20-10-10-9S[c] Raw Material Consumption (mt/mt product)	Coffee 20-10-10-9S[c] Cost (US $/mt product)	Coffee 26-13-13[d] Raw Material Consumption (mt/mt product)	Coffee 26-13-13[d] Cost (US $/mt product)
Ammonium sulfate (21% N, 24% S)	148	0.407	60.2	-	-
Urea (46% N)	193	0.172	33.2	0.460	88.8
Monoammonium phosphate (11% N, 52% P_2O_5)	264	-	-	-	-
Diammonium phosphate (18% N, 46% P_2O_5)	259	0.227	58.8	0.292	75.6
Potassium chloride (60% K_2O)	154	0.174	26.8	0.224	34.5
Micronutrient (boron) (66% B)	743	-	-	-	-
Conditioner (clay/oil)	150	0.020	3.0	0.024	3.6
Subtotal (raw materials)		1.000	182.0	1.000	202.5
Conversion cost			25.5		25.5
Total production cost (product basis)			207.5[f] 215.0[g]		228.0[f] 235.5[g]

(Continued)

Table III-18. Estimated Production Cost for Bulk-Blended Granular Fertilizers[a] (Continued)

Raw Material[b]	Cost (US $/mt)	Coffee 10-25-25[e] Raw Material Consumption (mt/mt product)	Coffee 10-25-25[e] Cost (US $/mt product)
Ammonium sulfate (21% N, 24% S)	148	-	-
Urea (46% N)	193	-	-
Monoammonium phosphate (11% N, 52% P_2O_5)	264	-	-
Diammonium phosphate (18% N, 46% P_2O_5)	259	0.556	144.0
Potassium chloride (60% K_2O)	154	0.425	65.5
Micronutrient (boron) (66% B)	743	-	-
Conditioner (clay/oil)	150	0.019	2.9
Subtotal (raw materials)		1.000	212.4
Conversion cost			25.5
Total production cost (product basis)			237.9[f] 245.4[g]

a. 1985 cost basis assuming recommended new production and marketing scheme.
b. N, P_2O_5, and K_2O materials are granular. Boron added as a powder in combination with conditioning-type oil.
c. Not recommended for acid soils because of acidifying effect of ammonium sulfate.
d. Not recommended because of potential caking tendency caused by large amount of urea in formulation.
e. Basal fertilizer to be supplemented with nitrogen (urea) topdressing.
f. At 100% capacity utilization, including bagging.
g. At 50% capacity utilization, including bagging.

Source: IFDC.

Working Capital--Working capital is estimated at US $3.0 million and US $5.0 million for 50% and 100% capacity utilization, respectively, for the complete bulk-blending and bagging facility. This translates into an average inventory of approximately 12,000 mt of material at 50% capacity utilization and 20,000 mt of material at 100% capacity utilization. A working capital of US $1.0 million is estimated for the bagging plant alone.

Conversion Cost--The conversion costs while operating at 50% capacity utilization and 100% capacity utilization are shown in Table III-16. The average conversion cost (including bulk blending and bagging) is estimated at US $31.9/mt at 50% capacity utilization (80,000 mtpy throughput) and US $24.5/mt at 100% capacity utilization (160,000 mtpy). If these costs are allocated separately to the bulk-blending and bagging operations, then the cost of bulk blending NPK products (including bagging) is estimated at US $33.0/mt and $25.5/mt for 50% and 100% capacity utilization, respectively. Likewise, the cost of bagging compound 20-10-10 or other straight materials (without bulk blending) is estimated at US $30.0/mt and $23.0/mt for 50% and 100% capacity utilization, respectively.

The cost of bagging in the recommended step one facility (bulk material unloading and bagging without bulk blending) is estimated at US $20.5/mt (Table III-17).

Production Cost--The estimated production cost (factory-gate price assuming production in Cameroon) for a number of bulk blends for use on food crops, cotton, and coffee is shown in Table III-18. The estimated costs (1985 basis) of raw materials used to prepare these bulk blends are shown in Table III-19.

Comparison of the Cost of Bulk Blends With Imported Granular Compounds--Of the bulk-blended grades shown in Table III-18, only three are directly comparable with currently imported granular compounds. They are 20-10-10 (coffee/food crops), 15-15-15-6S-1B_2O_3 (cotton), and 22-10-15-5S-1B_2O_3 (cotton). A summary of the estimated production costs of these grades compared with the "current" and "optimum cost" of imported compounds is shown in Table III-20. The "current cost" described in Table III-20 reflects the relatively high cost of freight that is currently paid because of the shipment of relatively small quantities of bagged material and other inefficiencies of the existing system. The lower estimated "optimum cost" of imported compounds (when compared with the current system) reflects savings in freight due to larger shipments of finished products and other improvements in the efficiency of the overall operation. The lower

Table III-19. Estimated Prices for Imported Fertilizer Raw Materials and Products Using Recommended New Fertilizer Supply and Marketing System[a]

Fertilizer Material	f.o.b. Price	Ocean Freight	Subtotal c. & f.	Other Cost[b]	Total
	(US $/mt)				
Ammonium sulfate[c]					
Bulk	80	50	130	18	148
Bagged	100	62	162	28	190 (226)[d] (206)[e]
Urea[c]					
Bulk	120	50	170	23	193
Bagged	140	62	202	32	234 (283)[e]
Diammonium phosphate[c]					
Bulk	180	50	230	29	259
Bagged	200	62	262	39	301 (335)
Monoammonium phosphate[c]					
Bulk	185	50	235	29	264
Bagged	205	62	267	39	306
Potassium chloride[c]					
Bulk	85	50	135	19	154
Bagged	105	62	167	28	194 (230)
20-10-10[c]					
Bulk	130	50	180	24	204
Bagged	150	62	212	33	245 (281)
15-15-15-6S-1B[c]					
Bulk	140	50	190	25	215
Bagged	160	62	222	34	256 (293)
22-10-15-5S-1B[c]					
Bulk	160	50	210	27	237
Bagged	180	62	242	37	279 (313)
Boron (66% B Solubor®)					
Bagged	560	100	660	83	743
Conditioning dust					
Bagged	65	62	127	23	150

a. Estimates based on average 1985 international fertilizer prices and ocean freight rates using Western Europe sources of supply.
b. Includes insurance, import taxes and custom charges, port handling, and material losses. These costs are estimated at 11% of c. & f. cost plus $4/mt for bulk materials and $10/mt for bagged materials.
c. Granular material.
d. Values in parentheses indicate reported costs for 1984/85.
e. Crystalline ammonium sulfate and prilled urea.

Source: Manufacturers' price data and IFDC.

Table III-20. Summary of Estimated Costs for Locally Produced Bulk Blends Compared With Imported Granular Compounds[a]

Grade	Estimated Cost			
	Imported Compound		Locally Produced Bulk Blend[c]	Bulk Blend Savings[e]
	Current[b]	Optimum[c]		
	(US $/mt)			
20-10-10 (coffee/food crops)	281[d]	245[d]	208	37
15-15-15-6S-1B (cotton)	293[d]	256[d]	226	30
22-10-15-5S-1B (cotton)	313[d]	279[d]	222	57

a. Cost of bagged product includes delivery to warehouse near Douala port (c.i.f. price plus all handling and related charges).
b. Reported costs for 1984/85.
c. Estimated (1985 cost basis) using improved fertilizer supply system (Tables III-18 and III-19).
d. Imported in 50-kg bags.
e. Compared with imported bagged compounds using optimum system.

Source: IFDC.

cost (US $30-$57/mt) for the bulk-blended equivalents of the three compounds using the improved supply system is due primarily to bulk blending being a less costly manufacturing process. Although the bulk-blended products described in this example (Table III-20) would be less costly to produce, the net savings may be less than indicated because it is unlikely that the quality (and therefore the agronomic response) of the bulk blends (containing 9%-30% urea) would be equivalent to that of the more homogeneous granular compound products. As previously mentioned, the quality of the bulk blends containing little or no urea is expected to be good and therefore the bulk-blending option should be restricted to grades such as 10-30-10-5S, 12-36-12, and 13-26-13-5S-1B. The production costs for these grades, while not directly comparable with those for imported compounds, were previously shown in Table III-18.

Comparison of Current System Costs With Proposed Bagging System Costs--Bulk blending is expected to supply only a portion of the total fertilizer needs. The importation of compounds (20-10-10, for example) and straight materials such as urea and potash is expected to continue. The cost of these imports can be significantly decreased by using the proposed fertilizer supply scheme. A summary of the estimated cost savings attained by using the proposed system compared with the current practice is shown in Table III-21. These data indicate a total savings of about US $55/mt (compared with the current system) if fertilizers are simply imported in bulk and bagged locally without bulk blending. About US $19/mt of the savings is attributed to local bagging; the remainder of the savings is due to lower freight rates for larger shipments of bulk material and other improvements in the overall efficiency of the proposed system.

Dockside Bagging

The cost for dockside bagging independent of the bulk-blending and bagging factory is estimated at US $16.8/mt assuming 60,000 mtpy (Table III-22). This is about US $6.2/mt less than the cost of bagging within the proposed bulk-blending facility (Table III-16, assuming 100% capacity utilization). This cost saving is attributed primarily to the lower capital investment required for dockside bagging if no storage is required. However, in practice it is unlikely that this degree of cost difference would actually exist since the dockside bagging operation would likely require additional support facilities such as trucks, short-term storage, and other related charges that are not included in the estimate.

Table III-21. Estimated Cost of Granular Fertilizers Using Current System and Proposed Bagging System[a]

Fertilizer	Current System[b]	Proposed System[c]	Savings[c] Total	Savings[c] Due to Local Bagging
	(US $/mt)			
Ammonium sulfate, 21% N	226	171 (190)[d]	55 (36)[d]	19
Urea, 46% N	283	216 (234)	67 (49)	18
Diammonium phosphate (DAP), 18% N, 46% P_2O_5	335	282 (301)	53 (34)	19
Monoammonium phosphate (MAP), 11% N, 52% P_2O_5	-	287 (306)	- (-)	-
Potassium chloride, 60% K_2O	230	177 (194)	53 (36)	17
20-10-10 compound	281	227 (245)	54 (36)	18
15-15-15-6S-1B compound	293	238 (256)	55 (37)	18
22-10-15-5S-1B compound	313	260 (279)	53 (34)	19

a. Cost of bagged product (in granular form) includes delivery to warehouse near Douala port (c.i.f. price plus all handling and related charges).
b. Reported costs for 1984/85 including ocean freight and all port handling charges (Table III-19).
c. Estimated cost and savings (1985 basis) using improved fertilizer supply system. Bulk fertilizer imports (Table III-19) with local bagging (at US $23/mt) is assumed.
d. Values in parentheses indicate estimated cost and savings if fertilizers are imported in bags and local bagging is not used.

Source: IFDC.

Table III-22. Estimated Cost for Dockside Bagging of Fertilizer

Premises:
1. Fixed capital investment US $250,000 (1985 basis)
2. Annual capacity 60,000 mt
3. 5-year equipment life
4. 15% annual interest on investment

Item	Basis	Annual Cost (US $ x 1,000)
Operating labor and supervision	US $1.0/mt	60
Electricity	US $0.1/mt	6
Maintenance labor and materials	10% of fixed investment	25
Administration and general overhead	200% of operating labor and supervision	120
Bags	US $12.0/mt	720
Fixed capital recovery	29.8% of US $250,000	75
Total		1,006
Unit cost, US $/mt		16.8

Source: IFDC.

Summary of Conclusions and Recommendations

The following conclusions and recommendations are indicated from the technical/economic assessment of the proposed ammonia/urea/DAP and fertilizer bulk-blending and bagging production schemes.

1. The construction of a small ammonia/urea and DAP complex based on 200 mtpd ammonia (84,000 mtpy urea) for the domestic market, and costing about US $191 million, is not recommended because of its high production cost in comparison with the cost of importing finished products (about 2 times higher for urea and about 1.4 times higher for DAP).
2. The construction of a large ammonia/urea and DAP complex based on 1,000 mtpd of ammonia (495,000 mtpy urea and 45,000 mtpy DAP), and costing about US $446 million, may be justified under the following conditions: (1) the export market is available to absorb the output of urea, (2) the average bulk urea f.o.b. price at the mid-point of the plant life (1995) increases to at least $260/mt in constant 1985 U.S. dollars, and (3) natural gas is priced at less than $3/million Btu. A more detailed feasibility study, including an analysis of the world urea and natural gas market, which is beyond the scope of the IFDC study, would be needed to confirm the project viability. The export market for ammonia should also be investigated.
3. Since DAP production is based on imported phosphoric acid, the DAP plant should be designed for the domestic market only. The economics of the DAP plant depends largely on the price of imported phosphoric acid and the cost of producing ammonia. In the large ammonia/urea/DAP complex, the DAP production accounts for less than 10% of the total complex output. Therefore the economics of the DAP plant has only a minor impact on the economics of the entire complex. Although the cost of producing DAP (in the large complex) is estimated at about 29% more (US $388/mt) than the estimated price of imported DAP (US $301/mt, Table III-19), its production can be justified if all or part of the fixed costs are charged to the urea plant. For example, if all of the DAP fixed costs are charged to the urea plant in the large complex, the DAP production cost would be decreased to $263.5/mt (a decrease of US $124.9/mt) and the urea production cost would be increased only slightly to US $248.1/mt (an increase of US $11.3/mt).
4. Installation of the bulk-blending plant is not recommended until it is demonstrated that the importation of fertilizers in bulk with local bagging

(Item 5) is technically and economically viable under the Cameroon conditions (technical and managerial expertise, availability of labor, functional port facilities, and overall mechanical performance of the equipment and facilities). Furthermore, bulk blending should be done only if a clear need for a bulk-blended line of products is established.

In the interim period (before installation of a bulk-blending plant), the fertilizer marketing system would obtain fertilizer materials from traditional European sources. However, the materials should be acquired in bulk and in lots of at least 5,000 mt. Bulk shipment of 5,000-mt lots, together with local bagging, is expected to decrease the cost of fertilizer (f.o.b. proposed Douala bagging plant) by about US $55/mt, a savings of about 20% when compared with the current practice of importing small lots of bagged products.

5. A fertilizer bagging plant having a capacity of at least 100,000 mtpy should be installed in the Douala area (outside the port authority's jurisdiction) as soon as possible. The proposed bagging plant complete with bulk unloading and storage facilities is expected to cost about US 1.84 million. The bagging plant should be designed to accommodate the easy add-on of bulk-blending capability if needed as described in Item 4. The bulk-blending facilities, including additional bulk raw material storage capability, would cost an additional US $2.59 million bringing the total investment to about US $4.43 million. The bulk-blended products are expected to save an additional US $30/mt-US $50/mt when compared with imported compound fertilizers that are bagged locally.

Bibliography

Africa Bureau. 1982. Africa Bureau Policy on Agricultural Input Subsidies, Agency for International Development, Washington, DC.

Atayi, E. A., and H. C. Knipscheer. 1980. Survey of Food Crop Farming Systems in the "Zapi-Est" East Cameroon. IITA/ONAREST, Ibadan, Nigeria.

Awa, E.M.T. 1975. "Seminaire National FAO/NORAD/Ministère Camerounais de l'Agriculture sur le Developpement de l'Emplois des Engrais au Cameroon," FAO, Rome, Italy.

Ayanaba, A., and B. T. Kang. 1976. "Urea Transformation in Some Tropical Soils," Soil Biol. Biochem., 8:313-316.

Barrault J., J. P. Eckebil, and J. Vaille. 1972. "Point des travaux de l'IRAT sur les sorghos repiqués du Nord Cameroun," Agronomie Tropicale, 27(8):791-814.

Birie, Habas J. 1981. "Expérimentation de la culture du blé sur les plateaux de l'Adamaoua au Cameroun (1974-1977)," Agronomie Tropicale, 36(3):224-245.

Braud, M. 1967. "La Fertilization minérale du cotonnier en Afrique tropicale et à Madagascar," Cot. Fib. Trop., 22(2):247-274.

Braud, M. 1974. "Le Controle de la nutrition minérale du cotonnier par analyse foliaire," Cot. Fib. Trop., 29(2):215-225.

Buol, S. W. 1972. "Fertility Capability Soil Classification System," IN Agronomic Economic Research on Tropical Soils, Annual Report for 1971-72, Soil Science Department, North Carolina State University, Raleigh, North Carolina.

Cameroon Development Corporation. 1985. Annual Report and Accounts for the 12 Months Ending 30 June 1984, Bota Limbe, Cameroon.

DeLancey, V. 1984. "Agricultural Productivity in Cameroon," Paper prepared for Country Day: Cameroon 1984 at the School of Advanced International Studies, the Johns Hopkins University, University of South Carolina, Columbia, South Carolina.

Desai, G. M. 1982. Sustaining Rapid Growth in India's Fertilizer Consumption: A Perspective Based on Composition of Use, Research Report 31, IFPRI, Washington, DC, August.

Diamond, R. B. 1983. "Agronomics of Urea Usage," in Nigeria Fertilizer Marketing Study, IFDC, Muscle Shoals, Alabama, U.S.A.

Dubernard, J. 1975. "L'apparition d'une déficience potassique au cours de rotations coton/cultures vivrières sur un sol ferrallitique en République Centrafricaine," Cot. Fib. Trop., 30(2):263-270.

Dubernard, J. 1978. "Role d'une fumure organique en culture cotonnière intensive sur des sols peu évolué d'apport du Nord Cameroun," Cot. Fib. Trop., 33(2):257-262.

Elliot Berg Associates. 1983. Agricultural Input Supply in Cameroon, Vols. I and II, The World Bank, Washington, D.C.

Food and Agriculture Organization of the United Nations. 1984. Projet Compte Rendu Final TCP/CMR/4401(A) Developpement de l'Emploi des Engrais, FAO, Rome, Italy.

Food and Agriculture Organization of the United Nations/Campagne Mondiale Contre de la Faim. 1974. Rapport au Gouvernement du Cameroun Programme Engrais, FAO, Rome, Italy.

Fritz, A. 1971. "La déficience en bore du cotonnier au Nord-Cameroon," Cot. Fib. Trop., 26(2):235-241.

Fritz, A., and M. Vallerie. 1971. "Contribution à l'étude des déficiences minérales des sols sous culture cotonnière au Nord-cameroun," Cot. Fib. Trop., 26(3):273-301.

Gagne-Gervais, C. 1984. Cameroon: The Cash Crop Sector: Its Performance and Future Development Possibilities, USAID, Yaounde, Cameroon.

Harris, G. T. 1985. "Forecasting Fertilizer Demand, Matching Methods With Means," Fertilizer International, No. 194.

Institute of Agronomic Research (IRA). 1983. Agro-Socio-Economic Survey of Farmers in the North-West Province, National Cereals Research and Extension Project.

Institute of Agronomic Research (IRA), Testing and Liaison Unit. 1984. 1983 Annual Report.

International Fertilizer Development Center (IFDC). 1984. "IFDC Mission Report on Cameroon Fertilizer Sector," Paper prepared for USAID/Cameroon, IFDC, Muscle Shoals, Alabama, U.S.A.

Kang, B. T., F. Donkoh, and K. Moody. 1977. "Soil Fertility Management Investigations on Benchmark Soils in the Humid, Low Altitude Tropics of West Africa," Agron. J., 69:651-657.

Kelso, B. F., and C. Gagne-Gervais. 1983. Study of the Food Crops Component of the Cameroon Extension Program and the Feasibility of Establishing Technical Support Centers, Agency for International Development, Yaounde, Cameroon.

Litwiller, W. F. 1985. "ARD Briefing Paper," Paper prepared for USAID/Cameroon Director, USAID, Yaounde, Cameroon.

McLindon, M. P., H. W. Ngenge, and T. Ayissi. 1983. Cocoa in Cameroon--Policy and Economics of Production, Ministry of Agriculture, Directorate of Studies and Projects, Yaounde, Cameroon.

Megie, C., et J. H. Ehrwein. 1976. "Contribution à l'etude de l'evolution de la fertilité d'un sol du continental terminal (Koro) dans les essais perennes de la station agronomique de Déli," Cot. Fib. Tropi., 31(2):241-266.

Megie, C., P. Louis, and P. Guibert. 1970. "Contribution à l'étude d'une formule de fumure minérale dans les sols du Tchad," Cot. Fib. Trop. 25(2):271-280.

MIDENO. 1983. Baseline Yields of Arabica Coffee, Maize, and Beans, North West Development Authority.

MIDENO. 1985. Extension Service Survey, 1984/85, May.

Ministry of Agriculture. 1985. 1984 Census of Agriculture, Unpublished data, Yaounde, Cameroon.

Ministry of Agriculture, Division of Agricultural Statistics. Yearbook of Agricultural Statistics, 1982-83. Yaounde, Cameroon (no date of publication given).

Moreau, D. 1983. Unpublished data on costs of producing coffee, UCCAO. Bofausoam, West Province.

Nye, P. H., and D. J. Greenland. 1960. The Soil Under the Shifting Cultivation, Tech. Comm. 51, Commonwealth Bureau of Soils, Harpenden, England.

Praquin, J. Y., and J. F. Richard. 1979. "Bilan des recherches menées sur le soja dans la zone d'altitude de l'ouest Cameroun," Agronomie Tropicale, 34(2):111-121.

Rapport Annuel d'Activites. 1982. Centre de Recherches Agronomiques de Nyombe, Dschang, Cameroon.

Sanchez, P. A. 1976. Properties and Management of Soils in the Tropics, John Wiley, New York.

Sanchez, P. A. 1979. "Advances in the Management of Oxisols and Ultisols in Tropical South America," IN Characterisation of Soils in Relation to Their Classification and Management: Examples From Some Areas of the Humid Tropics, D. J. England, (Ed.), Oxford University Press, London.

Seguy, L., J. Gigou, and M. Raunet. 1976. "Un exemple de relations: Etude du milieu physique, Experimentation agronomique, Mise en valeur: La culture du riz dans la plaine des M'Bos (Ouest Cameroun)," Agronomie Tropicale, 31(2):114-140.

The Testing and Liaison Unit - T.L.U. of the National Cereals Research and Extension Project (NCRC). 1983. "Presentation of Results 1983."

United Republic of Cameroon. 1981. The Fifth Five-Year Economic, Social and Cultural Development Plan 1981-1986, Ministry of Economic Affairs and Planning, National Printing Press, Yaounde, Cameroon.

United States Agency for International Development (USAID). 1985. "An Initiative Proposed Under the African Economic Policy Reform Program," Yaounde, Cameroon.

United States Department of Commerce, International Trade Administration. 1985. "Foreign Economic Trends and Their Implications for the United States--Cameroon," Prepared by the American Embassy, Yaounde, Cameroon.

Volk, G. M. 1966. "Efficiency of Fertilizer Urea as Affected by Method of Application, Soil Moisture, and Lime," Agron. J., 58:249-252.

Westphal, E. 1985. Cultures Vivrières Tropicales avec Référence Spéciale au Cameroun. Pudoc, Wageningen, The Netherlands.

PN AAV-407

Cameroon Fertilizer Sector Study

Appendices

Prepared by IFDC for USAID/Cameroon under contract number AFR-0510-A-00-5053-00.

May 1986

International Fertilizer Development Center/
United States Agency for International Development

334

APPENDIX A

Cameroon Fertilizer Use Projection

Scenario I

Table A-1. Scenario I--Cameroon Projected Total Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	12-6-20	Urea	Rock	DAP	TSP	KCl
	(mt)							
1986	16,126	40,381	8,000	18,555	3,458	1,470	389	9,304
1987	11,181	46,085	3,000	22,277	3,626	1,486	416	9,655
1988	10,238	50,749	0	24,261	3,801	1,503	445	10,022
1989	9,300	53,795	0	26,335	3,986	1,521	476	10,408
1990	8,364	57,012	0	28,515	4,180	1,539	509	10,813
1991	7,431	60,421	0	30,800	4,383	1,558	544	11,238
1992	7,499	64,045	0	32,738	4,596	1,578	581	11,685
1993	7,575	67,880	0	34,794	4,819	1,599	621	12,152
1994	7,651	71,946	0	36,974	5,053	1,621	663	12,642
1995	7,732	76,244	0	39,298	5,299	1,644	708	13,157

Year	Products						Total
	10-10-20	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)						(mt)
1986	987	4,789	11	11	6,799	8,178	118,458
1987	1,036	5,280	12	12	7,275	8,750	120,090
1988	1,088	5,837	13	13	7,784	9,363	125,117
1989	1,142	6,471	14	14	8,329	10,018	131,809
1990	1,199	7,194	15	15	8,912	10,719	138,986
1991	1,259	8,021	16	16	9,536	11,469	146,692
1992	1,322	8,970	17	17	10,204	12,272	155,524
1993	1,388	10,064	18	18	10,918	13,131	164,977
1994	1,457	11,327	19	19	11,682	14,050	175,104
1995	1,530	12,791	20	20	12,500	15,034	185,977

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	24,859	9,407	14,388	48,654
1987	26,352	9,979	14,410	50,741
1988	27,942	10,591	14,760	53,293
1989	29,638	11,249	15,582	56,469
1990	31,447	11,954	16,460	59,861
1991	33,376	12,710	17,399	63,485
1992	35,435	13,526	18,405	67,366
1993	37,635	14,404	19,483	71,522
1994	39,984	15,351	20,640	75,975
1995	42,500	16,375	21,883	80,758

Table A-2. Scenario I--Unsubsidized Sector (1985) Projected Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	Urea	Rock	DAP	TSP	KCl	10-10-20
	(mt)							
1986	1,126	652	6,642	3,458	1,470	389	9,304	987
1987	1,181	685	6,956	3,626	1,486	416	9,655	1,036
1988	1,239	719	7,290	3,801	1,503	445	10,022	1,088
1989	1,300	755	7,647	3,986	1,521	476	10,408	1,142
1990	1,365	793	8,028	4,180	1,539	509	10,813	1,199
1991	1,432	833	8,433	4,383	1,558	544	11,238	1,259
1992	1,501	875	8,865	4,596	1,578	581	11,685	1,322
1993	1,575	919	9,326	4,819	1,599	621	12,152	1,388
1994	1,652	965	9,817	5,053	1,621	663	12,642	1,457
1995	1,734	1,013	10,341	5,299	1,644	708	13,157	1,530

Year	Products					Total
	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)					(mt)
1986	4,789	11	11	6,799	8,178	43,816
1987	5,280	12	12	7,275	8,750	46,370
1988	5,837	13	13	7,784	9,363	49,117
1989	6,471	14	14	8,329	10,018	52,081
1990	7,194	15	15	8,912	10,719	55,281
1991	8,021	16	16	9,536	11,469	58,738
1992	8,970	17	17	10,204	12,272	62,483
1993	10,064	18	18	10,918	13,131	66,548
1994	11,327	19	19	11,682	14,050	70,967
1995	12,791	20	20	12,500	15,034	75,791

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	7,323	4,955	8,815	21,093
1987	7,764	5,259	9,270	22,293
1988	8,240	5,588	9,757	23,585
1989	8,754	5,945	10,278	24,977
1990	9,309	6,332	10,838	26,479
1991	9,910	6,751	11,440	28,101
1992	10,560	7,209	12,088	29,857
1993	11,267	7,708	12,787	31,762
1994	12,036	8,253	13,541	33,830
1995	12,874	8,852	14,360	36,086

Table A-3. Scenario 1--Subsidized Sector (1985) Projected Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	15,000	39,729	8,000	11,913	74,642
1987	10,000	45,400	3,000	15,321	73,720
1988	9,000	50,030	0	16,971	76,000
1989	8,000	53,040	0	18,688	79,728
1990	7,000	56,219	0	20,487	83,705
1991	6,000	59,588	0	22,367	87,954
1992	6,000	63,170	0	23,873	93,041
1993	6,000	66,961	0	25,468	98,429
1994	6,000	70,981	0	27,157	104,137
1995	6,000	75,231	0	28,957	110,186

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	17,536	4,453	5,573	27,562
1987	18,588	4,720	5,140	28,448
1988	19,702	5,003	5,003	29,708
1989	20,884	5,304	5,304	31,492
1990	22,138	5,622	5,622	33,382
1991	23,466	5,959	5,959	35,384
1992	24,875	6,317	6,317	37,509
1993	26,367	6,696	6,696	39,759
1994	27,948	7,098	7,098	42,144
1995	29,626	7,523	7,523	44,672

Table A-4. Scenario I--Central and South Provinces Projected Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	173	838	169	137	1,317
1987	115	958	64	176	1,313
1988	103	1,055	0	195	1,353
1989	92	1,119	0	215	1,426
1990	80	1,186	0	235	1,501
1991	69	1,257	0	257	1,583
1992	69	1,333	0	275	1,677
1993	69	1,413	0	293	1,775
1994	69	1,498	0	312	1,879
1995	69	1,587	0	333	1,989

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	287	94	118	449
1987	304	100	109	513
1988	322	106	106	534
1989	342	112	112	566
1990	362	119	119	600
1991	384	126	126	636
1992	408	133	133	674
1993	432	141	141	714
1994	458	150	150	758
1995	485	159	159	803

Table A-5. Scenario I--West Province[a] Projected Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	4,876	14,414	2,903	3,873	26,066
1987	3,251	16,471	1,088	4,982	25,792
1988	2,926	18,151	0	5,517	26,594
1989	2,600	19,243	0	6,076	27,919
1990	2,275	20,397	0	6,660	29,332
1991	1,950	21,619	0	7,271	30,840
1992	1,950	22,918	0	7,761	32,629
1993	1,950	24,293	0	8,279	34,522
1994	1,950	25,752	0	8,829	36,531
1995	1,950	27,294	0	9,414	38,658

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,037	1,616	2,022	9,675
1987	6,399	1,712	1,865	9,976
1988	6,782	1,815	1,815	10,412
1989	7,190	1,924	1,924	11,038
1990	7,621	2,040	2,040	11,701
1991	8,078	2,162	2,162	12,402
1992	8,563	2,292	2,292	13,147
1993	9,076	2,429	2,429	13,934
1994	9,621	2,575	2,575	14,771
1995	10,199	2,729	2,729	15,657

a. It is estimated that each year 6,000-12,000 mt of product purchased in the Littoral Province is used in the West Province.

Table A-6. Scenario I--East Province Projected Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products			
	AS	20-10-10	12-6-20	Urea
	(mt)			
1986	229	1,752	353	1,955
1987	159	2,002	132	2,002
1988	146	2,207	0	2,026
1989	133	2,339	0	2,050
1990	119	2,479	0	2,076
1991	107	2,627	0	2,103
1992	107	2,786	0	2,124
1993	108	2,953	0	2,147
1994	109	3,130	0	2,170
1995	110	3,318	0	2,196

Year	Products			Total
	DAP	TSP	KCl	
	(mt)			(mt)
1986	1,145	32	2,070	7,547
1987	1,145	34	2,070	7,557
1988	1,145	36	2,070	7,643
1989	1,145	38	2,070	7.789
1990	1,145	40	2,070	7,944
1991	1,145	42	2,070	8,110
1992	1,145	44	2,070	8,293
1993	1,145	46	2,070	8,487
1994	1,145	48	2,070	8,691
1995	1,145	50	2,070	8,909

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,546	738	1,493	3,777
1987	1,577	750	1,475	3,802
1988	1,610	764	1,469	3,843
1989	1,645	778	1,483	3,906
1990	1,682	793	1,497	3,972
1991	1,721	809	1,513	4,043
1992	1,763	826	1,529	4,118
1993	1,807	843	1,546	4,196
1994	1,853	862	1,565	4,280
1995	1,903	882	1,584	4,369

Table A-7. Scenario I--Northern Provinces Projected Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				
	AS	20-10-10	12-6-20	Urea	TSP
	(mt)				
1986	2,698	354	71	5,711	357
1987	1,799	404	27	6,574	382
1988	1,619	445	0	7,138	409
1989	1,439	472	0	7,733	438
1990	1,259	500	0	8,363	469
1991	1,079	530	0	9,028	502
1992	1,079	562	0	9,649	537
1993	1,079	596	0	10,311	575
1994	1,079	632	0	11,016	615
1995	1,079	670	0	11,768	658

Year	Products			Total
	15-15-15	15-20-15	22-10-15	
	(mt)			(mt)
1986	4,789	6,799	8,178	28,957
1987	5,280	7,275	8,750	30,491
1988	5,837	7,784	9,363	32,595
1989	6,471	8,329	10,018	34,900
1990	7,194	8,912	10,719	37,416
1991	8,021	9,536	11,469	40,165
1992	8,970	10,204	12,272	43,273
1993	10,064	10,918	13,131	46,674
1994	11,327	11,682	14,050	50,401
1995	12,791	12,500	15,034	54,500

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,810	3,100	3,015	12,925
1987	7,294	3,340	3,242	13,876
1988	7,815	3,601	3,492	14,908
1989	8,378	3,887	3,770	16,035
1990	8,985	4,199	4,074	17,258
1991	9,642	4,541	4,407	18,590
1992	10,353	4,917	4,773	20,043
1993	11,125	5,330	5,177	21,632
1994	11,963	5,787	5,622	23,372
1995	12,875	6,292	6,116	25,283

Table A-8. Scenario I--Littoral Province[a] Projected Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				
	AS	20-10-10	12-6-20	Urea	Rock
	(mt)				
1986	5,086	15,458	3,112	4,941	3,428
1987	3,455	17,665	1,167	6,109	3,594
1988	3,135	19,467	0	6,704	3,767
1989	2,816	10,638	0	7,323	3,950
1990	2,497	21,875	0	7,973	4,142
1991	2,178	23,187	0	8,651	4,343
1992	2,187	24,580	0	9,210	4,554
1993	2,198	26,054	0	9,802	4,775
1994	2,207	27,618	0	10,428	5,007
1995	2,218	29,272	0	11,093	5,251

Year	Products			Total
	DAP	KCl	10-10-20	
	(mt)			(mt)
1986	325	4,158	987	37,495
1987	341	4,355	1,036	37,722
1988	358	4,560	1,088	39,079
1989	376	4,776	1,142	41,021
1990	394	5,003	1,199	43,083
1991	413	5,241	1,259	45,272
1992	433	5,491	1,322	47,777
1993	454	5,753	1,388	50,424
1994	476	6,027	1,457	53,220
1995	499	6,314	1,530	56,177

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,963	3,009	4,860	14,832
1987	7,374	3,175	4,820	15,369
1988	7,809	3,350	4,900	16,059
1989	8,269	3,536	5,158	16,963
1990	8,758	3,731	5,429	17,918
1991	9,274	3,937	5,715	18,926
1992	9,822	4,156	6,017	19,995
1993	10,402	4,386	6,335	21,123
1994	11,015	4,629	6,669	22,313
1995	11,666	4,885	7,022	23,573

a. It is estimated that each year 6,000-12,000 mt of product purchased in the Littoral Province is used in the West Province.

Table A-9. Scenario I--South West Province Projected Total Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products							Total
	AS	20-10-10	12-6-20	Urea	Rock	KCl	SSP	
	(mt)							(mt)
1986	1,406	3,004	474	622	30	3,076	11	8,623
1987	1,297	3,373	177	741	32	3,230	12	8,862
1988	1,315	3,681	0	806	34	3,392	13	9,241
1989	1,336	3,895	0	873	36	3,562	14	9,716
1990	1,350	4,121	0	944	38	3,740	15	10,218
1991	1,385	4,360	0	1,018	40	3,927	16	10,746
1992	1,444	4,615	0	1,081	42	4,124	17	11,323
1993	1,508	4,884	0	1,148	44	4,329	18	11,931
1994	1,574	5,167	0	1,218	46	4,545	19	12,569
1995	1,643	5,467	0	1,294	48	4,773	20	13,245

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,239	340	2,241	3,820
1987	1,309	360	2,311	3,980
1988	1,383	381	2,403	4,167
1989	1,461	403	2,527	4,391
1990	1,544	427	2,656	4,627
1991	1,631	451	2,792	4,874
1992	1,724	478	2,936	5,138
1993	1,822	505	3,086	5,413
1994	1,924	534	3,244	5,702
1995	2,034	565	3,411	6,010

Table A-10. Scenario I--North West Province Projected Total Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	1,658	4,561	918	1,316	8,453
1987	1,105	5,212	344	1,693	8,354
1988	994	5,743	0	1,875	8,612
1989	884	6,089	0	2,065	9,038
1990	774	6,454	0	2,264	9,492
1991	663	6,841	0	2,472	9,976
1992	663	7,251	0	2,638	10,552
1993	663	7,687	0	2,814	11,164
1994	663	8,149	0	3,001	11,813
1995	663	8,636	0	3,200	12,499

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,976	511	640	3,127
1987	2,095	542	590	3,227
1988	2,220	574	574	3,368
1989	2,353	609	609	3,571
1990	2,495	645	645	3,785
1991	2,645	684	684	4,013
1992	2,803	725	725	4,253
1993	2,971	769	769	4,509
1994	3,149	815	815	4,779
1995	3,338	864	864	5,066

Table A-11. Scenario I--Bananas Projected Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products		Total
	Urea	KCl	
	- - - - - (mt)-	- - - -	(mt)
1986	1,279	840	2,119
1987	1,343	882	2,225
1988	1,410	926	2,336
1989	1,481	972	2,453
1990	1,556	1,021	2,577
1991	1,634	1,072	2,706
1992	1,716	1,126	2,842
1993	1,802	1,182	2,984
1994	1,892	1,241	3,133
1995	1,987	1,303	3,290

Year	Nutrients		Total
	N	K_2O	
	- - - - - (mt)	- - - -	(mt)
1986	588	504	1,092
1987	618	529	1,147
1988	649	556	1,205
1989	681	583	1,264
1990	716	613	1,329
1991	752	643	1,395
1992	789	676	1,465
1993	829	709	1,538
1994	870	745	1,615
1995	914	782	1,696

Table A-12. Scenario I--Cotton Projected Fertilizer Consumption Projections With Present Fertilizer Marketing Sytem and Current Fertilizer/ Crop Price Ratios

Year	Products					Total
	Urea	TSP	15-15-15	15-20-15	22-10-15	
	(mt)					(mt)
1986	3,568	357	3,589	6,799	8,178	22,491
1987	3,818	382	3,840	7,275	8,750	24,065
1988	4,085	409	4,109	7,784	9,363	25,750
1989	4,371	438	4,397	8,329	10,018	27,553
1990	4,677	469	4,705	8,912	10,719	29,482
1991	5,004	502	5,034	9,536	11,469	31,545
1992	5,354	537	5,386	10,204	12,272	33,753
1993	5,729	575	5,763	10,918	13,131	36,116
1994	6,130	615	6,166	11,682	14,050	38,643
1995	6,559	658	6,598	12,500	15,034	41,349

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	4,999	2,880	2,785	10,664
1987	5,349	3,082	2,980	11,411
1988	5,723	3,298	3,188	12,209
1989	6,124	3,529	3,412	13,065
1990	6,552	3,776	3,650	13,978
1991	7,011	4,040	3,906	14,957
1992	7,501	4,323	4,179	16,003
1993	8,026	4,626	4,472	17,124
1994	8,588	4,949	4,785	18,322
1995	9,189	5,296	5,120	19,605

Table A-13. Scenario I--Food Crops Projected Total Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	20-10-10	12-6-20	Urea	15-15-15	
	(mt)					(mt)
1986	5,091	7,757	1,562	4,044	1,200	19,654
1987	3,520	9,532	630	5,393	1,440	20,515
1988	3,281	11,238	0	6,187	1,728	22,434
1989	3,017	12,693	0	7,049	2,074	24,833
1990	2,728	14,280	0	7,985	2,489	27,482
1991	2,413	16,010	0	8,998	2,987	30,408
1992	2,488	17,902	0	9,904	3,584	33,878
1993	2,563	19,960	0	10,885	4,301	37,709
1994	2,639	22,200	0	11,947	5,161	41,947
1995	2,714	24,634	0	13,103	6,193	46,644

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	4,848	1,049	1,268	7,165
1987	5,418	1,207	1,295	7,920
1988	6,042	1,383	1,383	8,808
1989	6,726	1,580	1,580	9,886
1990	7,475	1,801	1,801	11,077
1991	8,296	2,049	2,049	12,394
1992	9,196	2,328	,328	13,852
1993	10,182	2,641	2,641	15,464
1994	11,264	2,994	2,994	17,252
1995	12,453	3,392	3,392	19,237

Table A-14. Scenario I--Coffee Projected Total Fertilizer Consumption With Present Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	9,909	31,972	6,438	7,869	56,188
1987	6,480	35,868	2,369	9,928	54,645
1988	5,718	38,792	0	10,784	55,294
1989	4,983	40,347	0	11,639	56,969
1990	4,271	41,939	0	12,502	58,712
1991	3,586	43,578	0	13,369	60,533
1992	3,510	45,268	0	13,969	62,747
1993	3,437	47,001	0	14,583	65,021
1994	3,360	48,781	0	15,210	67,351
1995	3,284	50,597	0	15,584	69,735

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	12,868	3,583	4,485	20,936
1987	13,386	3,729	4,061	21,176
1988	13,920	3,879	3,879	21,678
1989	14,470	4,035	4,035	22,540
1990	15,036	4,194	4,194	23,424
1991	15,618	4,358	4,358	24,334
1992	16,216	4,527	4,527	25,270
1993	16,830	4,700	4,700	26,230
1994	17,458	4,878	4,878	27,214
1995	18,102	5,060	5,060	28,222

Table A-15. Scenario I--Oil Palm Fertilizer Consumption Projections With Present Fertilizer Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	Urea	Rock	DAP	KCl	
	(mt)					(mt)
1986	373	10	2,408	26	5,271	8,088
1987	390	10	2,523	27	5,523	8,473
1988	408	10	2,643	28	5,787	8,876
1989	427	10	2,770	29	6,065	9,301
1990	448	10	2,903	30	6,356	9,747
1991	469	10	3,042	31	6,661	10,213
1992	491	10	3,188	32	6,982	10,703
1993	514	10	3,341	33	7,318	11,216
1994	538	10	3,501	34	7,670	11,753
1995	564	10	3,669	35	8,040	12,318

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	88	734	3,163	3,985
1987	91	769	3,314	4,174
1988	95	806	3,472	4,373
1989	99	844	3,639	4,582
1990	104	885	3,814	4,803
1991	109	927	3,997	5,033
1992	113	971	4,189	5,273
1993	118	1,017	4,391	5,526
1994	124	1,066	4,602	5,792
1995	129	1,117	4,824	6,070

Table A-16. Scenario I--Rubber Fertilizer Consumption Projections With Present Fertilizer Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	Rock	DAP	KCl	10-10-20	
	(mt)					(mt)
1986	278	1,050	299	1,088	987	3,702
1987	292	1,103	314	1,143	1,036	3,888
1988	307	1,158	330	1,200	1,088	4,083
1989	323	1,216	347	1,260	1,142	4,288
1990	339	1,277	364	1,323	1,199	4,502
1991	356	1,341	382	1,390	1,259	4,728
1992	373	1,408	401	1,460	1,322	4,964
1993	392	1,478	421	1,533	1,388	5,212
1994	412	1,552	442	1,610	1,457	5,473
1995	433	1,630	464	1,690	1,530	5,747

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	211	551	850	1,612
1987	221	579	893	1,693
1988	233	608	938	1,779
1989	244	639	984	1,867
1990	257	670	1,034	1,961
1991	269	704	1,086	2,059
1992	283	739	1,140	2,162
1993	297	776	1,197	2,270
1994	312	815	1,257	2,384
1995	327	855	1,320	2,502

Table A-17. Scenario I--Sugar Fertilizer Consumption Projections With Present Fertilizer Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products			Total
	Urea	DAP	KCl	
	(mt)			(mt)
1986	1,785	1,145	2,070	5,000
1987	1,785	1,145	2,070	5,000
1988	1,785	1,145	2,070	5,000
1989	1,785	1,145	2,070	5,000
1990	1,785	1,145	2,070	5,000
1991	1,785	1,145	2,070	5,000
1992	1,785	1,145	2,070	5,000
1993	1,785	1,145	2,070	5,000
1994	1,785	1,145	2,070	5,000
1995	1,785	1,145	2,070	5,000

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,027	527	1,242	2,796
1987	1,027	527	1,242	2,796
1988	1,027	527	1,242	2,796
1989	1,027	527	1,242	2,796
1990	1,027	527	1,242	2,796
1991	1,027	527	1,242	2,796
1992	1,027	527	1,242	2,796
1993	1,027	527	1,242	2,796
1994	1,027	527	1,242	2,796
1995	1,027	527	1,242	2,796

Table A-18. Scenario I--Tea Fertilizer Consumption Projections With Present Fertilizer Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	KCl	SSP	
	(mt)				(mt)
1986	459	652	35	11	1,157
1987	482	685	37	12	1,216
1988	506	719	39	13	1,277
1989	531	755	41	14	1,341
1990	558	793	43	15	1,409
1991	586	833	45	16	1,480
1992	615	875	47	17	1,554
1993	646	919	49	18	1,632
1994	678	965	51	19	1,713
1995	712	1,013	54	20	1,799

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	227	67	86	380
1987	238	71	91	400
1988	250	75	95	420
1989	263	78	100	441
1990	276	82	105	463
1991	290	87	110	487
1992	304	91	116	511
1993	319	96	121	536
1994	335	100	127	562
1995	352	105	134	591

Table A-19. Tobacco Fertilizer Consumption Projections With Present Fertilizer Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products			Total
	AS	TSP	KSO_4	
	(mt)			(mt)
1986	16	32	11	59
1987	17	34	12	63
1988	18	36	13	67
1989	19	38	14	71
1990	20	40	15	75
1991	21	42	16	79
1992	22	44	17	83
1993	23	46	18	87
1994	24	48	19	91
1995	25	50	20	95

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	3	15	6	24
1987	4	16	6	26
1988	4	17	7	28
1989	4	17	7	28
1990	4	18	8	30
1991	4	19	8	31
1992	5	20	9	34
1993	5	21	9	35
1994	5	22	10	37
1995	5	23	10	38

APPENDIX B

Cameroon Fertilizer Use Projection

Scenario II

Table B-1. Scenario II--Cameroon Projected Total Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	12-6-20	10-30-10	Urea	Rock	DAP	TSP
	(mt)							
1986	16,126	40,381	8,000	0	18,555	3,458	1,470	389
1987	11,181	46,085	3,000	0	22,277	3,626	1,486	416
1988	10,238	43,952	0	4,000	27,964	3,801	1,503	445
1989	9,300	41,377	0	8,000	33,488	3,986	1,521	476
1990	8,364	40,392	0	12,000	38,790	4,180	1,539	509
1991	7,431	41,283	0	16,000	43,792	4,383	1,558	544
1992	7,499	44,365	0	20,000	47,947	4,596	1,578	581
1993	7,575	46,998	0	25,000	52,703	4,819	1,599	621
1994	7,651	46,635	0	32,000	59,008	5,053	1,621	663
1995	7,732	46,763	0	40,000	65,634	5,299	1,644	708

Year	Products							Total
	KCl	10-10-20	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)							(mt)
1986	9,304	987	4,789	11	11	6,799	8,178	118,458
1987	9,655	1,036	5,280	12	12	7,275	8,750	120,090
1988	10,022	1,088	5,837	13	13	7,784	9,363	126,022
1989	10,408	1,142	6,471	14	14	8,329	10,018	134,542
1990	10,813	1,199	7,194	15	15	8,912	10,719	144,641
1991	11,238	1,259	8,021	16	16	9,536	11,469	156,548
1992	11,685	1,322	8,970	17	17	10,204	12,272	171,053
1993	12,152	1,388	10,064	18	18	10,918	13,131	187,005
1994	12,642	1,457	11,327	19	19	11,682	14,050	203,827
1995	13,157	1,530	12,791	20	20	12,500	15,034	222,832

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	24,859	9,407	14,388	48,654
1987	26,352	9,979	14,410	50,741
1988	28,686	11,111	14,480	54,277
1989	31,245	12,407	15,140	58,792
1990	34,049	13,892	15,998	63,939
1991	37,125	15,597	17,085	69,807
1992	40,496	17,558	18,437	76,491
1993	44,197	19,816	19,895	83,908
1994	48,257	22,420	21,308	91,985
1995	52,718	25,427	22,935	101,080

Table B-2. Scenario II--Subsidized Sector (1985) Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	20-10-10	12-6-20	10-30-10	Urea	
	(mt)					(mt)
1986	15,000	39,729	8,000	0	11,913	74,642
1987	10,000	45,400	3,000	0	15,321	73,720
1988	9,000	43,233	0	4,000	20,674	76,905
1989	8,000	40,622	0	8,000	25,841	82,461
1990	7,000	39,599	0	12,000	30,762	89,360
1991	6,000	40,450	0	16,000	35,359	97,810
1992	6,000	43,490	0	20,000	39,082	108,570
1993	6,000	46,079	0	25,000	43,377	120,457
1994	6,000	45,670	0	32,000	49,191	132,860
1995	6,000	45,750	0	40,000	55,293	147,041

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	17,536	4,453	5,573	27,562
1987	18,588	4,720	5,140	28,448
1988	20,446	5,523	4,723	30,692
1989	22,491	6,462	4,862	33,815
1990	24,740	7,560	5,160	37,460
1991	27,215	8,846	5,645	41,706
1992	29,935	10,349	6,349	46,633
1993	32,929	12,108	7,108	52,145
1994	36,222	14,167	7,767	58,156
1995	39,844	16,575	8,575	64,994

Table B-3. Scenario II--Unsubsidized Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	12-6-20	Urea	Rock	DAP	TSP	KCl
	(mt)							
1986								
1987								
1988	1,239	719	0	7,290	3,801	1,503	445	10,022
1989	1,300	755	0	7,647	3,986	1,521	476	10,408
1990	1,365	793	0	8,028	4,180	1,539	509	10,813
1991	1,432	833	0	8,433	4,383	1,558	544	11,238
1992	1,501	875	0	8,865	4,596	1,578	581	11,685
1993	1,575	919	0	9,326	4,819	1,599	621	12,152
1994	1,652	965	0	9,817	5,053	1,621	663	12,642
1995	1,734	1,013	0	10,341	5,299	1,644	708	13,157

Year	Products						Total
	10-10-20	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)						(mt)
1986							
1987							
1988	1,088	5,837	13	13	7,784	9,363	49,117
1989	1,142	6,471	14	14	8,329	10,018	52,081
1990	1,199	7,194	15	15	8,912	10,719	55,281
1991	1,259	8,021	16	16	9,536	11,469	58,738
1992	1,322	8,970	17	17	10,204	12,272	62,483
1993	1,388	10,064	18	18	10,918	13,131	66,548
1994	1,457	11,327	19	19	11,682	14,050	70,967
1995	1,530	12,791	20	20	12,500	15,034	75,791

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986				
1987				
1988	8,240	5,588	9,757	23,585
1989	8,754	5,945	10,278	24,977
1990	9,309	6,332	10,838	26,479
1991	9,910	6,751	11,440	28,101
1992	10,560	7,209	12,088	29,857
1993	11,267	7,708	12,787	31,762
1994	12,036	8,253	13,541	33,830
1995	12,874	8,852	14,360	36,086

Table B-4. Scenario II--Central and South Provinces Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	20-10-10	12-6-20	10-30-10	Urea	
	(mt)					(mt)
1986	173	838	169	0	137	1,317
1987	115	958	64	0	176	1,313
1988	103	913	0	84	238	1,338
1989	92	857	0	169	298	1,416
1990	80	835	0	253	354	1,522
1991	69	854	0	338	407	1,668
1992	69	918	0	422	449	1,858
1993	69	972	0	528	499	2,068
1994	69	964	0	675	565	2,273
1995	69	965	0	844	636	2,514

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	287	94	118	499
1987	304	100	109	513
1988	322	117	100	539
1989	345	136	103	584
1990	372	159	109	640
1991	406	187	119	712
1992	447	218	134	799
1993	491	256	150	897
1994	535	299	164	998
1995	584	350	181	1,115

Table B-5. Scenario II--West Province[a] Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	20-10-10	12-6-20	10-30-10	Urea	
	(mt)					(mt)
1986	4,876	14,414	2,903	0	3,873	26,066
1987	3,251	16,471	1,088	0	4,982	25,792
1988	2,926	15,684	0	1,451	6,722	26,783
1989	2,600	14,737	0	2,902	8,401	28,640
1990	2,275	14,367	0	4,353	10,000	30,995
1991	1,950	14,676	0	5,805	11,495	33,926
1992	1,950	15,778	0	7,256	12,706	37,690
1993	1,950	16,718	0	9,070	14,102	41,840
1994	1,950	16,569	0	11,610	15,992	46,121
1995	1,950	16,598	0	14,512	17,976	51,036

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,037	1,616	2,022	9,675
1987	6,399	1,712	1,865	9,976
1988	6,988	2,004	1,714	10,706
1989	7,648	2,344	1,764	11,756
1990	8,386	2,743	1,872	13,001
1991	9,213	3,209	2,048	14,470
1992	10,135	3,755	2,303	16,193
1993	11,147	4,393	2,579	18,119
1994	12,241	5,140	2,818	20,199
1995	13,449	6,013	3,111	22,573

a. It is estimated that each year 6,000-12,000 mt of product purchased in the Littoral Province is used in the West Province.

Table B-6. Scenario II--East Province Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				
	AS	20-10-10	12-6-20	10-30-10	Urea
	(mt)				
1986	229	1,752	353	0	1,955
1987	159	2,002	132	0	2,002
1988	146	1,907	0	176	2,078
1989	133	1,792	0	352	2,152
1990	119	1,746	0	529	2,222
1991	107	1,783	0	706	2,287
1992	107	1,918	0	882	2,340
1993	108	2,032	0	1,102	2,401
1994	109	2,014	0	1,411	2,484
1995	110	2,018	0	1,764	2,570

Year	Products				Total
	DAP	TSP	KCl	K_2SO_4	
	(mt)				
1986	1,145	32	2,070	11	7,547
1987	1,145	34	2,070	12	7,556
1988	1,145	36	2,070	13	7,571
1989	1,145	38	2,070	14	7,696
1990	1,145	40	2,070	15	7,886
1991	1,145	42	2,070	16	8,156
1992	1,145	44	2,070	17	8,523
1993	1,145	46	2,070	18	8,922
1994	1,145	48	2,070	19	9,300
1995	1,145	50	2,070	20	9,747

Year	Nutrients			Total
	N	P_2O_5	K_2O	(mt)
	(mt)			
1986	1,546	738	1,493	3,777
1987	1,577	750	1,475	3,802
1988	1,592	787	1,457	3,836
1989	1,618	829	1,463	3,910
1990	1,655	878	1,477	4,010
1991	1,708	936	1,499	4,143
1992	1,777	1,003	1,531	4,311
1993	1,850	1,082	1,564	4,496
1994	1,916	1,173	1,594	4,683
1995	1,991	1,281	1,630	4,902

Table B-7. Scenario II--Northern Provinces Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				
	AS	20-10-10	12-6-20	10-30-10	Urea
	(mt)				
1986	2,698	354	71	0	5,711
1987	1,799	404	27	0	6,574
1988	1,619	385	0	36	7,804
1989	1,439	362	0	71	9,020
1990	1,259	352	0	107	10,211
1991	1,079	360	0	142	11,365
1992	1,079	387	0	178	12,385
1993	1,079	410	0	223	13,532
1994	1,079	406	0	285	14,979
1995	1,079	407	0	356	16,506

Year	Products				Total
	TSP	15-15-15	15-20-15	22-10-15	
	(mt)				(mt)
1986	357	4,789	6,799	8,178	28,957
1987	382	5,280	7,275	8,750	30,491
1988	409	5,837	7,784	9,363	33,237
1989	438	6,471	8,329	10,018	36,148
1990	469	7,194	8,912	10,719	39,223
1991	502	8,021	9,536	11,469	42,474
1992	537	8,970	10,204	12,272	46,012
1993	575	10,064	10,918	13,131	49,932
1994	615	11,327	11,682	14,050	54,423
1995	658	12,791	12,500	15,034	59,331

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,810	3,100	3,015	12,925
1987	7,294	3,340	3,242	13,876
1988	8,113	3,606	3,490	15,209
1989	8,955	3,897	3,766	16,618
1990	9,817	4,216	4,070	18,103
1991	10,697	4,567	4,404	19,668
1992	11,595	4,953	4,773	21,321
1993	12,592	5,379	5,180	23,151
1994	13,769	5,849	5,628	25,246
1995	15,037	6,372	6,125	27,534

Table B-8. Scenario II--Littoral Province[a] Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				
	AS	20-10-10	12-6-20	10-30-10	Urea
	(mt)				
1986	5,086	15,458	3,112	0	4,941
1987	3,455	17,665	1,167	0	6,109
1988	3,135	16,821	0	1,556	7,916
1989	2,816	15,806	0	3,113	9,666
1990	2,497	15,408	0	4,669	11,339
1991	2,178	15,739	0	6,226	12,907
1992	2,187	16,922	0	7,782	14,194
1993	2,198	17,929	0	9,728	15,669
1994	2,207	17,770	0	12,451	17,646
1995	2,218	17,801	0	15,564	19,721

Year	Products				Total
	Rock	DAP	KCl	10-10-20	
	(mt)				(mt)
1986	3,428	325	4,158	987	37,495
1987	3,594	341	4,355	1,036	37,722
1988	3,767	358	4,560	1,088	39,201
1989	3,950	376	4,776	1,142	41,645
1990	4,142	394	5,003	1,199	44,651
1991	4,343	413	5,241	1,259	48,306
1992	4,554	433	5,491	1,322	52,885
1993	4,775	454	5,753	1,388	57,894
1994	5,007	476	6,027	1,457	63,041
1995	5,251	499	6,314	1,530	68,898

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,963	3,009	4,860	14,832
1987	7,374	3,175	4,820	15,369
1988	7,993	3,552	4,791	16,336
1989	8,692	3,987	4,986	17,665
1990	9,480	4,485	5,249	19,214
1991	10,365	5,060	5,593	21,018
1992	11,361	5,724	6,029	23,114
1993	12,448	6,491	6,495	25,434
1994	13,611	7,379	6,930	27,920
1995	14,897	8,407	7,431	30,735

a. It is estimated that each year 6,000-12,000 mt of product purchased in the Littoral Province is used in the West Province.

Table B-9. Scenario II--South West Province Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products								Total
	AS	20-10-10	12-6-20	10-30-10	Urea	Rock	KCl	SSP	
	(mt)								(mt)
1986	1,406	3,004	474	0	622	30	3,076	11	8,623
1987	1,297	3,373	177	0	741	32	3,230	12	8,862
1988	1,315	3,279	0	237	921	34	3,392	13	9,191
1989	1,336	3,160	0	473	1,096	36	3,562	14	9,677
1990	1,360	3,138	0	711	1,265	38	3,740	15	10,267
1991	1,385	3,227	0	948	1,424	40	3,927	16	10,967
1992	1,444	3,450	0	1,184	1,555	42	4,124	17	11,816
1993	1,508	3,647	0	1,480	1,707	44	4,329	18	12,733
1994	1,574	3,669	0	1,894	1,906	46	4,545	19	13,653
1995	1,643	3,722	0	2,368	2,115	48	4,773	20	14,689

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,239	340	2,241	3,820
1987	1,309	360	2,311	3,980
1988	1,379	412	2,387	4,178
1989	1,464	471	2,501	4,436
1990	1,566	542	2,629	4,737
1991	1,686	622	2,774	5,082
1992	1,827	716	2,938	5,481
1993	1,979	826	3,110	5,915
1994	2,131	953	3,283	6,367
1995	2,299	1,101	3,473	6,873

Table B-10. Scenario II--North West Province Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	20-10-10	12-6-20	10-30-10	Urea	
	(mt)					(mt)
1986	1,658	4,561	918	0	1,316	8,453
1987	1,105	5,212	344	0	1,693	8,354
1988	994	4,963	0	459	2,285	8,701
1989	884	4,663	0	918	2,855	9,320
1990	774	4,546	0	1,378	3,399	10,097
1991	663	4,644	0	1,837	3,907	11,051
1992	663	4,992	0	2,296	4,318	12,269
1993	663	5,290	0	2,870	4,793	13,616
1994	663	5,243	0	3,674	5,436	15,016
1995	663	5,252	0	4,592	6,110	16,617

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,976	511	640	3,127
1987	2,095	542	590	3,227
1988	2,298	634	542	3,474
1989	2,523	742	558	3,823
1990	2,773	868	592	4,233
1991	3,049	1,016	648	4,713
1992	3,354	1,188	729	5,271
1993	3,689	1,390	816	5,895
1994	4,056	1,627	892	6,575
1995	4,459	1,903	984	7,346

Table B-11. Scenario II--Bananas Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products		Total	Nutrients		Total
	Urea	KCl		N	K_2O	
	- - - - (mt)- - - -		(mt)	- - -(mt) - -		(mt)
1986	1,279	840	2,119	588	504	1,092
1987	1,343	882	2,225	618	529	1,147
1988	1,410	926	2,336	649	556	1,205
1989	1,481	972	2,453	681	583	1,264
1990	1,556	1,021	2,577	716	613	1,329
1991	1,634	1,072	2,706	752	643	1,395
1992	1,716	1,126	2,842	789	676	1,465
1993	1,802	1,182	2,984	829	709	1,538
1994	1,892	1,241	3,133	870	745	1,615
1995	1,987	1,303	3,290	914	782	1,696

Table B-12. Scenario II--Coffee Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	20-10-10	12-6-20	10-30-10	Urea	
	(mt)					(mt)
1986	9,909	31,972	6,438	0	7,869	56,188
1987	6,480	35,868	2,369	0	9,928	54,645
1988	5,718	35,072	0	1,550	13,136	55,476
1989	4,983	33,942	0	3,042	16,095	58,062
1990	4,271	34,017	0	4,476	18,773	61,537
1991	3,586	35,433	0	5,851	21,135	66,005
1992	3,510	38,332	0	7,166	22,870	71,878
1993	3,437	41,120	0	8,775	24,838	78,170
1994	3,360	42,383	0	10,995	27,550	84,288
1995	3,284	44,220	0	13,450	30,273	91,227

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	12,868	3,583	4,485	20,936
1987	13,386	3,729	4,061	21,176
1988	14,413	3,972	3,662	22,047
1989	15,543	4,307	3,698	23,548
1990	16,783	4,745	3,849	25,377
1991	18,147	5,299	4,128	27,574
1992	19,640	5,983	4,550	30,173
1993	21,249	6,745	4,990	32,983
1994	22,955	7,537	5,337	35,829
1995	24,804	8,457	5,767	39,028

Table B-13. Scenario II--Cotton Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	Urea	TSP	15-15-15	15-20-15	22-10-15	
	(mt)					(mt)
1986	3,568	357	3,589	6,799	8,178	22,491
1987	3,818	382	3,840	7,275	8,750	24,065
1988	4,085	409	4,109	7,784	9,363	25,750
1989	4,371	438	4,397	8,329	10,018	27,553
1990	4,677	469	4,705	8,912	10,719	29,482
1991	5,004	502	5,034	9,536	11,469	31,545
1992	5,354	537	5,386	10,204	12,272	33,753
1993	5,729	575	5,763	10,918	13,131	36,116
1994	6,130	615	6,166	11,682	14,050	38,643
1995	6,559	658	6,598	12,500	15,034	41,349

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	4,999	2,880	2,785	10,664
1987	5,349	3,082	2,980	11,411
1988	5,723	3,298	3,188	12,209
1989	6,124	3,529	3,412	13,065
1990	6,552	3,776	3,650	13,978
1991	7,011	4,040	3,906	14,957
1992	7,501	4,323	4,179	16,003
1993	8,026	4,626	4,472	17,124
1994	8,588	4,949	4,785	18,322
1995	9,189	5,296	5,120	19,605

Table B-14. Scenario II--Food Crop Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products						Total
	AS	20-10-10	12-6-20	10-30-10	Urea	15-15-15	
	(mt)						(mt)
1986	5,091	7,757	1,562	0	4,044	1,200	19,654
1987	3,520	9,532	630	0	5,393	1,440	20,515
1988	3,281	8,161	0	2,449	7,538	1,728	23,157
1989	3,017	6,680	0	4,956	9,746	2,074	26,473
1990	2,728	5,582	0	7,524	11,989	2,489	30,312
1991	2,413	5,017	0	10,151	14,224	2,987	34,792
1992	2,488	5,158	0	12,834	16,212	3,584	40,276
1993	2,563	4,959	0	16,226	18,539	4,301	46,588
1994	2,639	3,287	0	21,005	21,641	5,161	53,733
1995	2,714	1,530	0	26,550	25,020	6,193	62,007

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	4,848	1,049	1,268	7,165
1987	5,418	1,207	1,295	7,920
1988	6,293	1,810	1,320	9,423
1989	7,259	2,466	1,475	11,200
1990	8,330	3,189	1,684	13,203
1991	9,516	3,995	1,965	15,476
1992	10,833	4,904	2,337	18,073
1993	12,326	6,009	2,764	21,098
1994	14,041	7,404	3,203	24,649
1995	15,969	9,046	3,737	28,753

Table B-15. Scenario II--Palm Oil Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	Urea	Rock	DAP	KCl	
	(mt)					(mt)
1986	373	10	2,408	26	5,271	8,088
1987	390	10	2,523	27	5,523	8,473
1988	408	10	2,643	28	5,787	8,876
1989	427	10	2,770	29	6,065	9,301
1990	448	10	2,903	30	6,356	9,747
1991	469	10	3,042	31	6,661	10,213
1992	491	10	3,188	32	6,982	10,703
1993	514	10	3,341	33	7,318	11,216
1994	538	10	3,501	34	7,670	11,753
1995	564	10	3,669	35	8,040	12,318

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	88	734	3,163	3,985
1987	91	769	3,314	4,174
1988	95	806	3,472	4,373
1989	99	844	3,639	4,582
1990	104	885	3,814	4,803
1991	109	927	3,997	5,033
1992	113	971	4,189	5,273
1993	118	1,017	4,391	5,526
1994	124	1,066	4,602	5,792
1995	129	1,117	4,824	6,070

Table B-16. Scenario II--Rubber Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	AS	Products				Total	Nutrients			Total
		Rock	DAP	KCl	10-10-20		N	P_2O_5	K_2O	
		(mt)				(mt)	(mt)			(mt)
1986	278	1,050	299	1,088	987	3,702	211	551	850	1,612
1987	292	1,103	314	1,143	1,036	3,888	221	579	893	1,693
1988	307	1,158	330	1,200	1,088	4,083	233	608	938	1,779
1989	323	1,216	347	1,260	1,142	4,288	244	639	984	1,867
1990	339	1,277	364	1,323	1,199	4,502	257	670	1,034	1,961
1991	356	1,341	382	1,390	1,259	4,728	269	704	1,086	2,059
1992	373	1,408	401	1,460	1,322	4,964	283	739	1,140	2,162
1993	392	1,478	421	1,533	1,388	5,212	297	776	1,197	2,270
1994	412	1,552	442	1,610	1,457	5,473	312	815	1,257	2,384
1995	433	1,630	464	1,690	1,530	5,747	327	855	1,320	2,502

Table B-17. Scenario II--Sugar Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products			Total	Nutrients			Total
	Urea	DAP	KCl		N	P_2O_5	K_2O	
	- - - - -	(mt)	- - - - -	(mt)	- - - - -	(mt)	- - - - -	(mt)
1986	1,785	1,145	2,070	5,000	1,027	527	1,242	2,796
1987	1,785	1,145	2,070	5,000	1,027	527	1,242	2,796
1988	1,785	1,145	2,070	5,000	1,027	527	1,242	2,796
1989	1,785	1,145	2,070	5,000	1,027	527	1,242	2,796
1990	1,785	1,145	2,070	5,000	1,027	527	1,242	2,796
1991	1,785	1,145	2,070	5,000	1,027	527	1,242	2,796
1992	1,785	1,145	2,070	5,000	1,027	527	1,242	2,796
1993	1,785	1,145	2,070	5,000	1,027	527	1,242	2,796
1994	1,785	1,145	2,070	5,000	1,027	527	1,242	2,796
1995	1,785	1,145	2,070	5,000	1,027	527	1,242	2,796

Table B-18. Scenario II--Tea Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products				Total	Nutrients			Total
	AS	20-10-10	KCl	SSP	(mt)	N	P_2O_5	K_2O	(mt)
	- - - - - - - -(mt)- - - - - - - -					- - - - (mt)- - - -			
1986	459	652	35	11	1,157	227	67	86	380
1987	482	685	37	12	1,216	238	71	91	400
1988	506	719	39	13	1,277	250	75	95	420
1989	531	755	41	14	1,341	263	78	100	441
1990	558	793	43	15	1,409	276	82	105	463
1991	586	833	45	16	1,480	290	87	110	487
1992	615	875	47	17	1,554	304	91	116	511
1993	646	919	49	18	1,632	319	96	121	536
1994	678	965	51	19	1,713	335	100	127	562
1995	712	1,013	54	20	1,799	352	105	134	591

Table B-19. Scenario II--Tobacco Projected Fertilizer Consumption With Recommended Marketing System and Current Fertilizer/Crop Price Ratios

Year	Products			Total	Nutrients			Total
	AS	TSP	K_2SO_4		N	P_2O_5	K_2O	
	- - - - - (mt) - - - - -			(mt)	- - - - (mt) - - - -			(mt)
1986	16	32	11	59	3	15	6	24
1987	17	34	12	63	4	16	6	26
1988	18	36	13	67	4	17	7	28
1989	19	38	14	71	4	17	7	28
1990	20	40	15	75	4	18	8	30
1991	21	42	16	79	4	19	8	31
1992	22	44	17	83	5	20	9	34
1993	23	46	18	87	5	21	9	35
1994	24	48	19	91	5	22	10	37
1995	25	50	20	95	5	23	10	38

APPENDIX C

Cameroon Fertilizer Use Projection

Scenario III

Table C-1. Scenario III--Cameroon Projected Total Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	12-6-20	Urea	Rock	DAP	TSP	KCl
	(mt)							
1986	16,126	40,381	8,000	18,555	3,458	1,470	389	9,304
1987	11,181	41,903	3,000	19,821	3,626	1,486	416	9,655
1988	10,238	43,204	0	20,644	3,801	1,503	445	10,022
1989	9,300	44,134	0	21,516	3,986	1,521	476	10,408
1990	8,364	45,124	0	22,443	4,180	1,539	509	10,813
1991	7,431	46,184	0	23,426	4,383	1,558	544	11,238
1992	7,499	47,321	0	24,341	4,596	1,578	581	11,685
1993	7,575	48,536	0	25,319	4,819	1,599	621	12,152
1994	7,651	49,834	0	26,360	5,053	1,621	663	12,642
1995	7,732	51,218	0	27,474	5,299	1,644	708	13,157

Year	Products						Total
	10-10-20	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)						(mt)
1986	987	4,789	11	11	6,799	8,178	118,458
1987	1,036	5,220	12	12	7,275	8,750	113,392
1988	1,088	5,696	13	13	7,784	9,363	113,814
1989	1,142	6,222	14	14	8,329	10,018	117,080
1990	1,199	6,804	15	15	8,912	10,719	120,636
1991	1,259	7,448	16	16	9,536	11,469	124,508
1992	1,322	8,162	17	17	10,204	12,272	129,595
1993	1,388	8,955	18	18	10,918	13,131	135,049
1994	1,457	9,837	19	19	11,682	14,050	140,888
1995	1,530	10,820	20	20	12,500	15,034	147,156

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	24,859	9,407	14,388	48,654
1987	24,376	9,552	13,983	47,911
1988	24,748	9,816	13,984	48,548
1989	25,452	10,246	14,579	50,277
1990	26,218	10,706	15,213	52,137
1991	27,050	11,201	15,889	54,140
1992	28,107	11,732	16,612	56,451
1993	29,241	12,303	17,382	58,926
1994	30,455	12,916	18,205	61,576
1995	31,760	13,577	19,085	64,422

Table C-2. Scenario III--Subsidized Sector (1985) Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	15,000	39,729	8,000	11,913	74,642
1987	10,000	41,218	3,000	12,865	67,082
1988	9,000	42,485	0	13,354	64,838
1989	8,000	43,379	0	13,869	65,248
1990	7,000	44,331	0	14,415	65,745
1991	6,000	45,351	0	14,993	66,343
1992	6,000	46,446	0	15,476	67,920
1993	6,000	47,617	0	15,993	69,610
1994	6,000	48,869	0	16,543	71,411
1995	6,000	50,205	0	17,133	73,336

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	17,536	4,453	5,573	27,562
1987	16,621	4,302	4,722	25,645
1988	16,530	4,249	4,249	25,028
1989	16,736	4,338	4,338	25,412
1990	16,967	4,433	4,433	25,833
1991	17,227	4,535	4,535	26,297
1992	17,668	4,645	4,645	26,958
1993	18,140	4,762	4,762	27,664
1994	18,643	4,887	4,887	28,417
1995	19,182	5,021	5,021	29,224

Table C-3. Scenario III--Unsubsidized Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products						
	AS	20-10-10	Urea	Rock	DAP	TSP	KCl
	(mt)						
1986	1,126	652	6,642	3,458	1,470	389	9,304
1987	1,181	685	6,956	3,626	1,486	416	9,655
1988	1,239	719	7,290	3,801	1,503	445	10,022
1989	1,300	755	7,647	3,986	1,521	476	10,408
1990	1,365	793	8,028	4,180	1,539	509	10,813
1991	1,432	833	8,433	4,383	1,558	544	11,238
1992	1,501	875	8,865	4,596	1,578	581	11,685
1993	1,575	919	9,326	4,819	1,599	621	12,152
1994	1,652	965	9,817	5,053	1,621	663	12,642
1995	1,734	1,013	10,341	5,299	1,644	708	13,157

Year	Products						Total
	10-10-20	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)						(mt)
1986	987	4,789	11	11	6,799	8,178	43,816
1987	1,036	5,220	12	12	7,275	8,750	46,310
1988	1,088	5,696	13	13	7,784	9,363	48,976
1989	1,142	6,222	14	14	8,329	10,018	51,832
1990	1,199	6,804	15	15	8,912	10,719	54,891
1991	1,259	7,448	16	16	9,536	11,469	58,165
1992	1,322	8,162	17	17	10,204	12,272	61,675
1993	1,388	8,955	18	18	10,918	13,131	65,439
1994	1,457	9,837	19	19	11,682	14,050	69,477
1995	1,530	10,820	20	20	12,500	15,034	73,820

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	7,323	4,955	8,815	21,093
1987	7,755	5,250	9,261	22,266
1988	8,219	5,567	9,736	23,522
1989	8,716	5,908	10,241	24,865
1990	9,251	6,273	10,780	26,304
1991	9,824	6,666	11,354	27,844
1992	10,439	7,087	11,967	29,493
1993	11,101	7,541	12,620	31,262
1994	11,812	8,029	13,318	33,159
1995	12,578	8,556	14,065	35,199

Table C-4. Scenario III--Central and South Provinces Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	173	838	169	137	1,317
1987	115	866	64	146	1,191
1988	103	890	0	151	1,144
1989	92	907	0	156	1,155
1990	80	924	0	161	1,165
1991	69	944	0	166	1,179
1992	69	964	0	171	1,204
1993	69	986	0	176	1,231
1994	69	1,008	0	181	1,258
1995	69	1,033	0	187	1,289

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	287	94	118	499
1987	272	90	99	461
1988	269	89	89	447
1989	272	91	91	454
1990	276	92	92	460
1991	280	94	94	468
1992	486	96	96	478
1993	293	99	99	491
1994	299	101	101	501
1995	307	103	103	513

Table C-5. Scenario III--West Province[a] Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	4,876	14,414	2,903	3,873	26,066
1987	3,215	15,023	1,088	4,186	23,548
1988	2,926	15,546	0	4,351	22,823
1989	2,600	15,920	0	4,528	23,048
1990	2,275	16,320	0	4,715	23,310
1991	1,950	16,748	0	4,916	23,614
1992	1,950	17,209	0	5,085	24,244
1993	1,950	17,702	0	5,268	24,920
1994	1,950	18,232	0	5,464	25,646
1995	1,950	18,797	0	5,675	26,422

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,037	1,616	2,022	9,675
1987	5,743	1,568	1,720	9,031
1988	5,725	1,555	1,555	8,835
1989	5,813	1,592	1,592	8,997
1990	5,911	1,632	1,632	9,175
1991	6,020	1,675	1,675	9,370
1992	6,190	1,721	1,721	9,632
1993	6,373	1,770	1,770	9,913
1994	6,569	1,823	1,823	10,215
1995	6,779	1,880	1,880	10,539

a. It is estimated that each year 6,000-12,000 mt of product purchased in the Littoral Province is used in the West Province.

Table C-6. Scenario III--East Province Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products								Total
	AS	20-10-10	12-6-20	Urea	DAP	TSP	KCl	K_2SO_4	
	(mt)								(mt)
1986	229	1,752	353	1,955	1,145	32	2,070	11	7,547
1987	159	1,812	132	1,966	1,145	34	2,070	12	7,330
1988	146	1,862	0	1,972	1,145	36	2,070	13	7,244
1989	133	1,897	0	1,977	1,145	38	2,070	14	7,274
1990	119	1,934	0	1,984	1,145	40	2,070	15	7,307
1991	107	1,973	0	1,991	1,145	42	2,070	16	7,344
1992	107	2,015	0	1,997	1,145	44	2,070	17	7,395
1993	108	2,060	0	2,002	1,145	46	2,070	18	7,449
1994	109	2,108	0	2,009	1,145	48	2,070	19	7,508
1995	110	2,159	0	2,016	1,145	50	2,070	20	7,570

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,546	738	1,493	3,777
1987	1,522	731	1,456	3,709
1988	1,516	729	1,435	3,680
1989	1,523	734	1,439	3,696
1990	1,531	739	1,443	3,713
1991	1,539	743	1,447	3,729
1992	1,550	748	1,452	3,750
1993	1,562	754	1,457	3,773
1994	1,575	760	1,462	3,797
1995	1,588	766	1,468	3,822

Table C-7. Scenario III--Northern Provinces Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products								Total
	AS	20-10-10	12-6-20	Urea	TSP	15-15-15	15-20-15	22-10-15	
	(mt)								(mt)
1986	2,698	354	71	5,711	357	4,789	6,799	8,178	28,957
1987	1,799	374	27	6,206	382	5,220	7,275	8,750	30,033
1988	1,619	390	0	6,592	409	5,696	7,784	9,363	31,853
1989	1,439	401	0	7,002	438	6,222	8,329	10,018	33,849
1990	1,259	412	0	7,437	469	6,804	8,912	10,719	36,012
1991	1,079	424	0	7,899	502	7,448	9,536	11,469	38,357
1992	1,079	437	0	8,358	537	8,162	10,204	12,272	41,049
1993	1,079	451	0	8,848	575	8,955	10,918	13,131	43,957
1994	1,079	465	0	9,370	615	9,837	11,682	14,050	47,098
1995	1,079	480	0	9,928	658	10,820	12,500	15,034	50,499

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,810	3,100	3,015	12,925
1987	7,110	3,328	3,230	13,668
1988	7,532	3,575	3,465	14,572
1989	7,990	3,842	3,725	15,557
1990	8,483	4,132	4,006	16,621
1991	9,016	4,445	4,310	17,771
1992	9,613	4,783	4,639	19,035
1993	10,257	5,150	4,996	20,403
1994	10,949	5,546	5,382	21,877
1995	11,695	5,977	5,801	23,473

Table C-8. Scenario III--Littoral Province[a] Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products								Total
	AS	20-10-10	12-6-20	Urea	Rock	DAP	KCl	10-10-20	
	(mt)								(mt)
1986	5,086	15,458	3,112	4,941	3,428	325	4,158	987	37,495
1987	3,455	15,983	1,167	5,250	3,594	341	4,355	1,036	35,181
1988	3,135	16,426	0	5,437	3,767	358	4,560	1,088	34,771
1989	2,816	16,732	0	5,632	3,950	376	4,776	1,142	35,424
1990	2,497	17,057	0	5,840	4,142	394	5,003	1,199	36,132
1991	2,178	17,406	0	6,059	4,343	413	5,241	1,259	36,899
1992	2,187	17,779	0	6,256	4,554	433	5,491	1,322	38,022
1993	2,198	18,175	0	6,464	4,775	454	5,753	1,388	39,207
1994	2,207	18,600	0	6,684	5,007	476	6,027	1,457	40,458
1995	2,218	19,052	0	6,919	5,251	499	6,314	1,530	41,783

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,963	3,009	4,860	14,832
1987	6,642	3,007	4,652	14,301
1988	6,618	3,046	4,596	14,260
1989	6,710	3,145	4,767	14,622
1990	6,813	3,249	4,947	15,009
1991	6,926	3,359	5,137	15,422
1992	7,103	3,475	5,337	15,915
1993	7,291	3,598	5,547	16,436
1994	7,489	3,727	5,768	16,984
1995	7,702	3,863	6,000	17,565

a. It is estimated that each year 6,000-12,000 mt of product purchased in the Littoral Province is used in the West Province.

Table C-9. Scenario III--South West Province Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products							Total
	AS	20-10-10	12-6-20	Urea	Rock	KCl	SSP	
	(mt)							(mt)
1986	1,406	3,004	474	622	30	3,076	11	8,623
1987	1,297	3,117	177	659	32	3,230	12	8,524
1988	1,315	3,218	0	685	34	3,392	13	8,657
1989	1,336	3,300	0	712	36	3,562	14	8,960
1990	1,360	3,388	0	741	38	3,740	15	9,282
1991	1,385	3,481	0	771	40	3,927	16	9,620
1992	1,444	3,580	0	799	42	4,124	17	10,006
1993	1,508	3,685	0	830	44	4,329	18	10,414
1994	1,574	3,795	0	862	46	4,545	19	10,841
1995	1,643	3,912	0	896	48	4,773	20	11,292

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,239	340	2,241	3,820
1987	1,220	334	2,285	3,839
1988	1,235	335	2,357	3,927
1989	1,268	344	2,467	4,079
1990	1,304	353	2,583	4,240
1991	1,342	363	2,704	4,409
1992	1,387	374	2,832	4,593
1993	1,435	385	2,966	4,786
1994	1,486	397	3,107	4,990
1995	1,540	410	3,255	5,205

Table C-10. Scenario III--North West Province Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	1,658	4,561	918	1,316	8,453
1987	1,105	4,728	344	1,408	7,585
1988	994	4,872	0	1,456	7,322
1989	884	4,977	0	1,509	7,370
1990	774	5,089	0	1,565	7,428
1991	663	5,208	0	1,624	7,495
1992	663	5,337	0	1,675	7,675
1993	663	5,477	0	1,731	7,871
1994	663	5,626	0	1,790	8,079
1995	663	5,785	0	1,853	8,301

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,976	511	640	3,127
1987	1,867	493	542	2,902
1988	1,853	487	487	2,827
1989	1,875	498	498	2,871
1990	1,900	509	509	2,918
1991	1,928	521	521	2,970
1992	1,977	534	534	3,045
1993	2,031	548	548	3,127
1994	2,088	563	563	3,214
1995	2,149	579	579	3,307

Table C-11. Scenario III--Bananas Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products		Total
	Urea	KCl	
	- - - - - - - -(mt)- - - - - - - -		(mt)
1986	1,279	840	2,119
1987	1,343	882	2,225
1988	1,410	926	2,336
1989	1,481	972	2,453
1990	1,556	1,021	2,577
1991	1,634	1,072	2,706
1992	1,716	1,126	2,842
1993	1,802	1,182	2,984
1994	1,892	1,241	3,133
1995	1,987	1,303	3,290

Year	Nutrients		Total
	N	K_2O	
	- - - - - - - (mt)- - - - - - -		(mt)
1986	588	504	1,092
1987	618	529	1,147
1988	649	556	1,205
1989	681	583	1,264
1990	716	613	1,329
1991	752	643	1,395
1992	789	676	1,465
1993	829	709	1,538
1994	870	745	1,615
1995	914	782	1,696

Table C-12. Scenario III--Subsidized (1985) Coffee Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	12-6-20	Urea	
	(mt)				(mt)
1986	9,909	31,972	6,438	7,869	56,188
1987	6,480	32,751	2,369	8,282	49,882
1988	5,718	33,336	0	8,452	47,506
1989	4,983	33,647	0	8,623	47,253
1990	4,271	33,965	0	8,795	47,031
1991	3,586	34,293	0	8,969	46,848
1992	3,510	34,631	0	9,088	47,229
1993	3,437	34,978	0	9,212	47,627
1994	3,360	35,334	0	9,337	48,031
1995	3,284	35,697	0	9,466	48,447

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	12,868	3,583	4,485	20,936
1987	12,005	3,417	3,749	19,171
1988	11,756	3,334	3,334	18,424
1989	11,742	3,365	3,365	18,472
1990	11,736	3,397	3,397	18,530
1991	11,737	3,429	3,429	18,595
1992	11,844	3,463	3,463	18,770
1993	11,955	3,498	3,498	18,951
1994	12,067	3,533	3,533	19,133
1995	12,183	3,570	3,570	19,323

Table C-13. Scenario III--Cotton Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products					Total
	Urea	TSP	15-15-15	15-20-15	22-10-15	
	(mt)					(mt)
1986	3,568	357	3,589	6,799	8,178	22,491
1987	3,818	382	3,840	7,275	8,750	24,065
1988	4,085	409	4,109	7,784	9,363	25,750
1989	4,371	438	4,397	8,329	10,018	27,553
1990	4,677	469	4,705	8,912	10,719	29,482
1991	5,004	502	5,034	9,536	11,469	31,545
1992	5,354	537	5,386	10,204	12,272	33,753
1993	5,729	575	5,763	10,918	13,131	36,116
1994	6,130	615	6,166	11,682	14,050	38,643
1995	6,559	658	6,598	12,500	15,034	41,349

Year	Products			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	4,999	2,880	2,785	10,664
1987	5,349	3,082	2,980	11,411
1988	5,723	3,298	3,188	12,209
1989	6,124	3,529	3,412	13,065
1990	6,552	3,776	3,650	13,978
1991	7,011	4,040	3,906	14,957
1992	7,501	4,323	4,179	16,003
1993	8,026	4,626	4,472	17,124
1994	8,588	4,949	4,785	18,322
1995	9,189	5,296	5,120	19,605

Table C-14. Scenario III--Food Crop Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	20-10-10	12-6-20	Urea	15-15-15	
	(mt)					(mt)
1986	5,091	7,757	1,562	4,044	1,200	19,654
1987	3,520	8,467	630	4,583	1,380	18,580
1988	3,281	9,149	0	4,902	1,587	18,919
1989	3,017	9,732	0	5,246	1,825	19,820
1990	2,728	10,366	0	5,620	2,099	20,813
1991	2,413	11,058	0	6,024	2,414	21,909
1992	2,488	11,815	0	6,388	2,776	23,467
1993	2,563	12,639	0	6,781	3,192	25,175
1994	2,639	13,535	0	7,206	3,671	27,051
1995	2,714	14,508	0	7,667	4,222	29,111

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	4,848	1,049	1,268	7,165
1987	4,823	1,092	1,180	7,095
1988	5,012	1,153	1,153	7,318
1989	5,267	1,247	1,247	7,761
1990	5,546	1,351	1,351	8,248
1991	5,851	1,468	1,468	8,787
1992	6,240	1,598	1,598	9,436
1993	6,664	1,743	1,743	10,150
1994	7,127	1,904	1,904	10,935
1995	7,632	2,084	2,084	11,800

Table C-15. Scenario III--Oil Palm Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	Urea	Rock	DAP	KCl	
	(mt)					(mt)
1986	373	10	2,408	26	5,271	8,088
1987	390	10	2,523	27	5,523	8,473
1988	408	10	2,643	28	5,787	8,876
1989	427	10	2,770	29	6,065	9,301
1990	448	10	2,903	30	6,356	9,747
1991	469	10	3,042	31	6,661	10,213
1992	491	10	3,188	32	6,982	10,703
1993	514	10	3,341	33	7,318	11,216
1994	538	10	3,501	34	7,670	11,753
1995	564	10	3,669	35	8,040	12,318

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	88	734	3,163	3,985
1987	91	769	3,314	4,174
1988	95	806	3,472	4,373
1989	99	844	3,639	4,582
1990	104	885	3,814	4,803
1991	109	927	3,997	5,033
1992	113	971	4,189	5,273
1993	118	1,017	4,391	5,526
1994	124	1,066	4,602	5,792
1995	129	1,117	4,824	6,070

Table C-16. Scenario III--Rubber Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	Rock	DAP	KCl	10-10-20	
	(mt)					(mt)
1986	278	1,050	299	1,088	987	3,702
1987	292	1,103	314	1,143	1,036	3,888
1988	307	1,158	330	1,200	1,088	4,083
1989	323	1,216	347	1,260	1,142	4,288
1990	339	1,277	364	1,323	1,199	4,502
1991	356	1,341	382	1,390	1,259	4,728
1992	373	1,408	401	1,460	1,322	4,964
1993	392	1,478	421	1,533	1,388	5,212
1994	412	1,552	442	1,610	1,457	5,473
1995	433	1,630	464	1,690	1,530	5,747

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	211	551	850	1,612
1987	221	579	893	1,693
1988	233	608	938	1,779
1989	244	639	984	1,867
1990	257	670	1,034	1,961
1991	269	704	1,086	2,059
1992	283	739	1,140	2,162
1993	297	776	1,197	2,270
1994	312	815	1,257	2,384
1995	327	855	1,320	2,502

Table C-17. Scenario III--Sugar Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products			Total
	Urea	DAP	KCl	
	(mt)			(mt)
1986	1,785	1,145	2,070	5,000
1987	1,785	1,145	2,070	5,000
1988	1,785	1,145	2,070	5,000
1989	1,785	1,145	2,070	5,000
1990	1,785	1,145	2,070	5,000
1991	1,785	1,145	2,070	5,000
1992	1,785	1,145	2,070	5,000
1993	1,785	1,145	2,070	5,000
1994	1,785	1,145	2,070	5,000
1995	1,785	1,145	2,070	5,000

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,027	527	1,242	2,796
1987	1,027	527	1,242	2,796
1988	1,027	527	1,242	2,796
1989	1,027	527	1,242	2,796
1990	1,027	527	1,242	2,796
1991	1,027	527	1,242	2,796
1992	1,027	527	1,242	2,796
1993	1,027	527	1,242	2,796
1994	1,027	527	1,242	2,796
1995	1,027	527	1,242	2,796

Table C-18. Scenario III--Tea Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	KCl	SSP	
	(mt)				(mt)
1986	459	652	35	11	1,157
1987	482	685	37	12	1,216
1988	506	719	39	13	1,277
1989	531	755	41	14	1,341
1990	558	793	43	15	1,409
1991	586	833	45	16	1,480
1992	615	875	47	17	1,554
1993	646	919	49	18	1,632
1994	678	965	51	19	1,713
1995	712	1,013	54	20	1,799

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	227	67	86	380
1987	238	71	91	400
1988	250	75	95	420
1989	263	78	100	441
1990	276	82	105	463
1991	290	87	110	487
1992	304	91	116	511
1993	319	96	121	536
1994	335	100	127	562
1995	352	105	134	591

Table C-19. Scenario III--Tobacco Projected Fertilizer Consumption With Present Marketing System and High Fertilizer/Crop Price Ratios

Year	Products			Total
	AS	TSP	K_2SO_4	
	- - - - - - - -(mt)- - - - - - - -			(mt)
1986	16	32	11	59
1987	17	34	12	63
1988	18	36	13	67
1989	19	38	14	71
1990	20	40	15	75
1991	21	42	16	79
1992	22	44	17	83
1993	23	46	18	87
1994	24	48	19	91
1995	25	50	20	95

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	- - - - - - (mt) - - - - - -			(mt)
1986	3	15	6	24
1987	4	16	6	26
1988	4	17	7	28
1989	4	17	7	28
1990	4	18	8	30
1991	4	19	8	31
1992	5	20	9	34
1993	5	21	9	35
1994	5	22	10	37
1995	5	23	10	38

APPENDIX D

Cameroon Fertilizer Use Projection

Scenario IV

Table D-1. Scenario IV--Cameroon Projected Total Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	10-30-10	Urea	Rock	DAP	TSP	KCl
	(mt)							
1986	16,126	40,381	8,000[a]	18,555	3,458	1,470	389	9,304
1987	11,181	41,903	3,000[a]	19,821	3,626	1,486	416	9,655
1988	10,238	40,346	2,689	25,247	3,801	1,503	445	10,022
1989	9,300	38,031	5,390	29,184	3,986	1,521	476	10,408
1990	8,364	37,099	8,106	32,987	4,180	1,539	509	10,813
1991	7,431	37,783	10,832	36,605	4,383	1,558	544	11,238
1992	7,499	40,342	13,567	40,157	4,596	1,578	581	11,685
1993	7,575	42,505	16,997	43,140	4,819	1,599	621	12,152
1994	7,651	42,100	21,802	47,721	5,053	1,621	663	12,642
1995	7,732	42,115	27,311	52,550	5,299	1,644	708	13,157

a. 12-6-20.

Year	Products						Total
	10-10-20	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)						(mt)
1986	987	4,789	11	11	6,799	8,178	118,458
1987	1,036	5,220	12	12	7,275	8,750	113,392
1988	1,088	5,696	13	13	7,784	9,363	118,248
1989	1,142	6,222	14	14	8,329	10,018	124,035
1990	1,199	6,804	15	15	8,912	10,719	131,261
1991	1,259	7,448	16	16	9,536	11,469	140,118
1992	1,322	8,162	17	17	10,204	12,272	151,999
1993	1,388	8,955	18	18	10,918	13,131	163,836
1994	1,457	9,837	19	19	11,682	14,050	176,317
1995	1,530	10,820	20	20	12,500	15,034	190,440

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			
1986	24,859	9,407	14,388	48,654
1987	24,376	9,552	13,983	47,911
1988	26,563	10,337	13,967	50,867
1989	28,297	11,252	14,508	54,057
1990	30,273	12,336	15,221	57,830
1991	32,516	13,610	16,132	62,258
1992	35,343	15,104	17,271	67,718
1993	37,932	16,799	18,479	73,210
1994	40,915	18,684	19,612	79,211
1995	44,205	20,860	20,906	85,971

Table D-2. Scenario IV--Subsidized Sector (1985) Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	10-30-10	Urea	
	(mt)				(mt)
1986	15,000	39,729	8,000[a]	11,913	74,642
1987	10,000	41,218	3,000[a]	12,865	67,082
1988	9,000	39,627	2,689	17,957	69,272
1989	8,000	37,276	5,390	21,537	72,203
1990	7,000	36,306	8,106	24,959	76,370
1991	6,000	36,950	10,832	28,172	81,953
1992	6,000	39,467	13,567	31,292	90,324
1993	6,000	41,586	16,997	33,814	98,397
1994	6,000	41,135	21,802	37,904	106,840
1995	6,000	41,102	27,311	42,209	116,620

a. 12-6-20.

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	17,536	4,453	5,573	27,562
1987	16,621	4,302	4,722	25,645
1988	18,344	4,769	4,232	27,345
1989	19,581	5,345	4,267	29,193
1990	21,023	6,062	4,441	31,526
1991	22,692	6,945	4,778	34,415
1992	24,904	8,017	5,303	38,224
1993	26,831	9,258	5,858	41,947
1994	29,103	10,654	6,294	46,051
1995	31,627	12,304	6,841	50,772

Table D-3. Scenario IV--Unsubsidized Sector (1985) Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products						
	AS	20-10-10	Urea	Rock	DAP	TSP	KCl
	(mt)						
1986	1,126	652	6,642	3,458	1,470	389	9,304
1987	1,181	685	6,956	3,626	1,486	416	9,655
1988	1,239	719	7,290	3,801	1,503	445	10,022
1989	1,300	755	7,647	3,986	1,521	476	10,408
1990	1,365	793	8,028	4,180	1,539	509	10,813
1991	1,432	833	8,433	4,383	1,558	544	11,238
1992	1,501	875	8,865	4,596	1,578	581	11,685
1993	1,575	919	9,326	4,819	1,599	621	12,152
1994	1,652	965	9,817	5,053	1,621	663	12,642
1995	1,734	1,013	10,341	5,299	1,644	708	13,157

Year	Products						Total
	10-10-20	15-15-15	SSP	K_2SO_4	15-20-15	22-10-15	
	(mt)						(mt)
1986	987	4,789	11	11	6,799	8,178	43,816
1987	1,036	5,220	12	12	7,275	8,750	46,310
1988	1,088	5,696	13	13	7,784	9,363	48,976
1989	1,142	6,222	14	14	8,329	10,018	51,832
1990	1,199	6,804	15	15	8,912	10,719	54,891
1991	1,259	7,448	16	16	9,536	11,469	58,165
1992	1,322	8,162	17	17	10,204	12,272	61,675
1993	1,388	8,955	18	18	10,918	13,131	65,439
1994	1,457	9,837	19	19	11,682	14,050	69,477
1995	1,530	10,820	20	20	12,500	15,034	73,820

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	7,323	4,955	8,815	21,093
1987	7,755	5,250	9,261	22,266
1988	8,219	5,567	9,736	23,522
1989	8,716	5,908	10,241	24,865
1990	9,251	6,273	10,780	26,304
1991	9,824	6,666	11,354	27,844
1992	10,439	7,087	11,967	29,493
1993	11,101	7,541	12,620	31,262
1994	11,812	8,029	13,318	33,159
1995	12,578	8,556	14,065	35,199

Table D-4. Scenario IV--Central and South Provinces Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	10-30-10	Urea	
	(mt)				(mt)
1986	173	838	169	137	1,317
1987	115	866	64	146	1,191
1988	103	830	55	204	1,192
1989	92	779	112	244	1,227
1990	80	759	169	282	1,290
1991	69	774	226	318	1,387
1992	69	829	281	352	1,531
1993	69	874	352	380	1,675
1994	69	866	452	424	1,811
1995	69	866	566	473	1,974

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	287	94	118	499
1987	272	90	99	461
1988	287	100	89	476
1989	299	112	89	500
1990	315	127	93	535
1991	338	145	100	583
1992	370	167	111	648
1993	399	193	123	715
1994	428	222	132	782
1995	462	256	143	861

Table D-5. Scenario IV--West Province[a] Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	10-30-10	Urea	
	(mt)				(mt)
1986	4,876	14,414	2,903	3,873	26,066
1987	3,215	15,023	1,088	4,186	23,548
1988	2,926	14,561	996	5,843	24,326
1989	2,600	13,716	1,996	7,012	25,324
1990	2,275	13,361	3,004	8,132	26,772
1991	1,950	13,577	4,018	9,186	28,731
1992	1,950	14,451	5,036	10,212	31,649
1993	1,950	15,185	6,313	11,047	34,495
1994	1,950	15,011	8,104	12,394	37,459
1995	1,950	14,986	10,158	13,815	40,909

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,037	1,616	2,022	9,675
1987	5,743	1,568	1,720	9,031
1988	6,314	1,755	1,556	9,625
1989	6,714	1,970	1,571	10,255
1990	7,191	2,237	1,637	11,065
1991	7,752	2,563	1,760	12,075
1992	8,501	2,956	1,949	13,406
1993	9,159	3,412	2,150	14,721
1994	9,923	3,932	2,312	16,167
1995	10,777	4,546	2,514	17,837

a. It is estimated that each year 6,000-12,000 mt of product purchased in the Littoral Province is used in the West Province.

Table D-6. Scenario IV--East Province Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products								Total
	AS	20-10-10	10-30-10	Urea	DAP	TSP	KCl	K_2SO_4	
	(mt)								(mt)
1986	229	1,752	353[a]	1,955	1,145	32	2,070	11	7,547
1987	159	1,812	132[a]	1,966	1,145	34	2,070	12	7,330
1988	146	1,733	116	2,037	1,145	36	2,070	13	7,296
1989	133	1,629	234	2,086	1,145	38	2,070	14	7,349
1990	119	1,587	352	2,133	1,145	40	2,070	15	7,461
1991	107	1,616	470	2,177	1,145	42	2,070	16	7,643
1992	107	1,732	589	2,220	1,145	44	2,070	17	7,924
1993	108	1,828	737	2,254	1,145	46	2,070	18	8,206
1994	109	1,809	944	2,311	1,145	48	2,070	19	8,455
1995	110	1,810	1,182	2,369	1,145	50	2,070	20	8,756

a. 12-6-20.

Year	Products			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,546	738	1,493	3,777
1987	1,522	731	1,456	3,709
1988	1,532	751	1,433	3,716
1989	1,543	777	1,435	3,755
1990	1,565	809	1,443	3,817
1991	1,600	849	1,459	3,908
1992	1,655	897	1,483	4,035
1993	1,705	952	1,508	4,165
1994	1,748	1,013	1,527	4,288
1995	1,799	1,085	1,551	4,435

Table D-7. Scenario IV--Northern Provinces Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				
	AS	20-10-10	10-30-10	Urea	TSP
	(mt)				
1986	2,698	354	71[a]	5,711	357
1987	1,799	374	27[a]	6,206	382
1988	1,619	388	27	7,410	409
1989	1,439	371	53	8,394	438
1990	1,259	363	80	9,363	469
1991	1,079	369	107	10,311	502
1992	1,079	389	134	11,261	537
1993	1,079	407	167	12,117	575
1994	1,079	404	214	13,303	615
1995	1,079	404	267	14,555	658

a. 12-6-20.

Year	Products			Total
	15-15-15	15-20-15	22-10-15	
	(mt)			(mt)
1986	4,789	6,799	8,178	28,957
1987	5,220	7,275	8,750	30,033
1988	5,696	7,784	9,363	32,696
1989	6,222	8,329	10,018	35,264
1990	6,804	8,912	10,719	37,969
1991	7,448	9,536	11,469	40,821
1992	8,162	10,204	12,272	44,038
1993	8,955	10,918	13,131	47,349
1994	9,837	11,682	14,050	51,184
1995	10,820	12,500	15,034	55,317

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,810	3,100	3,015	12,925
1987	7,110	3,328	3,230	13,668
1988	7,911	3,583	3,468	14,962
1989	8,630	3,855	3,728	16,213
1990	9,368	4,151	4,010	17,529
1991	10,125	4,471	4,316	18,912
1992	10,953	4,818	4,648	20,419
1993	11,768	5,195	5,008	21,971
1994	12,767	5,604	5,397	23,768
1995	13,835	6,050	5,820	25,705

Table D-8. Scenario IV--Littoral Province[a] Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products								Total
	AS	20-10-10	10-30-10	Urea	Rock	DAP	KCl	10-10-20	
	(mt)								(mt)
1986	5,086	15,458	3,112[b]	4,941	3,428	325	4,158	987	37,495
1987	3,455	15,983	1,167[b]	5,250	3,594	341	4,355	1,036	35,181
1988	3,135	15,288	1,032	6,956	3,767	358	4,560	1,088	36,184
1989	2,816	14,370	2,067	8,145	3,950	376	4,776	1,142	37,642
1990	2,497	13,997	3,105	9,285	4,142	394	5,003	1,199	39,622
1991	2,178	14,264	4,146	10,361	4,343	413	5,241	1,259	42,205
1992	2,187	15,275	5,190	11,411	4,554	433	5,491	1,322	45,863
1993	2,198	16,129	6,498	12,274	4,775	454	5,753	1,388	49,469
1994	2,207	15,964	8,330	13,635	5,007	476	6,027	1,457	53,103
1995	2,218	15,964	10,428	15,067	5,251	499	6,314	1,530	57,271

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	6,963	3,009	4,860	14,832
1987	6,642	3,007	4,652	14,301
1988	7,192	3,242	4,586	15,020
1989	7,601	3,529	4,738	15,868
1990	8,096	3,875	4,952	16,923
1991	8,691	4,289	5,237	18,217
1992	9,492	4,782	5,606	19,880
1993	10,204	5,342	5,992	21,538
1994	10,993	5,962	6,337	23,292
1995	11,875	6,683	6,734	25,292

a. It is estimated that each year 6,000-12,000 mt of product purchased in the Littoral Province is used in the West Province.
b. 12-6-20.

Table D-9. Scenario IV--South West Province Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products							
	AS	20-10-10	10-30-10	Urea	Rock	KCl	SSP	Total
	(mt)							
1986	1,406	3,004	474[a]	622	30	3,076	11	8,623
1987	1,297	3,117	177[a]	659	32	3,230	12	8,524
1988	1,315	3,045	157	830	34	3,392	13	8,786
1989	1,336	2,941	315	951	36	3,562	14	9,155
1990	1,360	2,924	473	1,069	38	3,740	15	9,619
1991	1,385	3,003	631	1,181	40	3,927	16	10,183
1992	1,444	3,199	790	1,291	42	4,124	17	10,907
1993	1,508	3,373	989	1,383	44	4,329	18	11,644
1994	1,574	3,394	1,267	1,524	46	4,545	19	12,369
1995	1,643	3,442	1,587	1,672	48	4,773	20	13,185

a. 12-6-20.

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,239	340	2,241	3,820
1987	1,220	334	2,285	3,839
1988	1,283	364	2,355	4,002
1989	1,338	402	2,463	4,203
1990	1,409	449	2,584	4,442
1991	1,498	505	2,720	4,723
1992	1,616	573	2,873	5,062
1993	1,726	651	3,034	5,411
1994	1,837	737	3,193	5,767
1995	1,961	839	3,367	6,167

Table D-10. Scenario IV--North West Province Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	10-30-10	Urea	
	(mt)				(mt)
1986	1,658	4,561	918[a]	1,316	8,453
1987	1,105	4,728	344[a]	1,408	7,585
1988	994	4,501	306	1,967	7,768
1989	884	4,225	613	2,352	8,074
1990	774	4,108	923	2,723	8,528
1991	663	4,180	1,234	3,071	9,148
1992	663	4,467	1,547	3,410	10,087
1993	663	4,709	1,941	3,685	10,998
1994	663	4,652	2,491	4,130	11,936
1995	663	4,643	3,123	4,599	13,028

a. 12-6-20.

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,976	511	640	3,127
1987	1,867	493	542	2,902
1988	2,044	542	481	3,067
1989	2,174	606	484	3,264
1990	2,329	688	503	3,520
1991	2,511	788	541	3,840
1992	2,756	911	601	4,268
1993	2,970	1,053	665	4,688
1994	3,219	1,213	714	5,146
1995	3,496	1,401	777	5,674

Table D-11. Scenario IV--Bananas Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products		Total	Nutrients		Total
	Urea	KCl		N	K_2O	
	- - - -(mt)- - - -		(mt)	- - -(mt)- - -		(mt)
1986	1,279	840	2,119	588	504	1,092
1987	1,343	882	2,225	618	529	1,147
1988	1,410	926	2,336	649	556	1,205
1989	1,481	972	2,453	681	583	1,264
1990	1,556	1,021	2,577	716	613	1,329
1991	1,634	1,072	2,706	752	643	1,395
1992	1,716	1,126	2,842	789	676	1,465
1993	1,802	1,182	2,984	829	709	1,538
1994	1,892	1,241	3,133	870	745	1,615
1995	1,987	1,303	3,290	914	782	1,696

Table D-12. Scenario IV--Coffee Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	10-30-10	Urea	
	(mt)				(mt)
1986	9,909	31,972	6,438[a]	7,869	56,188
1987	6,480	32,751	2,369[a]	8,282	49,882
1988	5,718	31,177	1,007	11,293	49,195
1989	4,983	29,787	1,977	13,216	49,963
1990	4,271	29,497	2,910	14,956	51,634
1991	3,586	30,426	3,803	16,491	54,306
1992	3,510	32,708	4,657	17,895	58,770
1993	3,437	34,814	5,704	18,899	62,854
1994	3,360	35,396	7,147	20,661	66,564
1995	3,284	36,435	8,742	22,432	70,893

a. 12-6-20.

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	12,868	3,583	4,485	20,936
1987	12,005	3,417	3,749	19,171
1988	12,732	3,420	3,218	19,370
1989	13,281	3,572	3,176	20,029
1990	13,967	3,823	3,241	21,030
1991	14,804	4,184	3,423	22,411
1992	15,976	4,668	3,737	24,381
1993	16,949	5,193	4,052	26,193
1994	18,004	5,684	4,254	27,942
1995	19,170	6,266	4,518	29,953

Table D-13. Scenario IV--Cotton Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products					Total
	Urea	TSP	15-15-15	15-20-15	22-10-15	
	(mt)					(mt)
1986	3,568	357	3,589	6,799	8,178	22,491
1987	3,818	382	3,840	7,275	8,750	24,065
1988	4,085	409	4,109	7,784	9,363	25,750
1989	4,371	438	4,397	8,329	10,018	27,553
1990	4,677	469	4,705	8,912	10,719	29,482
1991	5,004	502	5,034	9,536	11,469	31,545
1992	5,354	537	5,386	10,204	12,272	33,753
1993	5,729	575	5,763	10,918	13,131	36,116
1994	6,130	615	6,166	11,682	14,050	38,643
1995	6,559	658	6,598	12,500	15,034	41,349

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	4,999	2,880	2,785	10,664
1987	5,349	3,082	2,980	11,411
1988	5,723	3,298	3,188	12,209
1989	6,124	3,529	3,412	13,065
1990	6,552	3,776	3,650	13,978
1991	7,011	4,040	3,906	14,957
1992	7,501	4,323	4,179	16,003
1993	8,026	4,626	4,472	17,124
1994	8,588	4,949	4,785	18,322
1995	9,189	5,296	5,120	19,605

Table D-14. Scenario IV--Food Crops Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	20-10-10	10-30-10	Urea	15-15-15	
	(mt)					(mt)
1986	5,091	7,757	1,562[a]	4,044	1,200	18,454
1987	3,520	8,467	630[a]	4,583	1,380	17,200
1988	3,281	8,450	1,682	6,664	1,587	21,664
1989	3,017	7,489	3,413	8,321	1,825	24,065
1990	2,728	6,809	5,196	10,003	2,099	26,835
1991	2,413	6,524	7,029	11,681	2,414	30,061
1992	2,488	6,759	8,910	13,397	2,776	34,330
1993	2,563	6,772	11,293	14,915	3,192	38,735
1994	2,639	5,739	14,655	17,243	3,671	43,947
1995	2,714	4,667	18,569	19,777	4,222	49,949

a. 12-6-20.

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	4,848	1,049	1,268	7,165
1987	4,923	1,109	1,198	7,230
1988	5,851	1,588	1,251	8,690
1989	6,574	2,047	1,364	9,985
1990	7,371	2,555	1,515	11,440
1991	8,250	3,123	1,717	13,090
1992	9,344	3,765	1,983	15,093
1993	10,362	4,544	2,285	17,191
1994	11,650	5,521	2,590	19,761
1995	13,091	6,671	2,957	22,719

Table D-15. Scenario IV--Palm Oil Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	Urea	Rock	DAP	KCl	
	(mt)					(mt)
1986	373	10	2,408	26	5,271	8,088
1987	390	10	2,523	27	5,523	8,473
1988	408	10	2,643	28	5,787	8,876
1989	427	10	2,770	29	6,065	9,301
1990	448	10	2,903	30	6,356	9,747
1991	469	10	3,042	31	6,661	10,213
1992	491	10	3,188	32	6,982	10,703
1993	514	10	3,341	33	7,318	11,216
1994	538	10	3,501	34	7,670	11,753
1995	564	10	3,669	35	8,040	12,318

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	88	734	3,163	3,985
1987	91	769	3,314	4,174
1988	95	806	3,472	4,373
1989	99	844	3,639	4,582
1990	104	885	3,814	4,803
1991	109	927	3,997	5,033
1992	113	971	4,189	5,273
1993	118	1,017	4,391	5,526
1994	124	1,066	4,602	5,792
1995	129	1,117	4,824	6,070

Table D-16. Scenario IV--Rubber Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products					Total
	AS	Rock	DAP	KCl	10-10-20	
	(mt)					(mt)
1986	278	1,050	299	1,088	987	3,702
1987	292	1,103	314	1,143	1,036	3,888
1988	307	1,158	330	1,200	1,088	4,083
1989	323	1,216	347	1,260	1,142	4,288
1990	339	1,277	364	1,323	1,199	4,502
1991	356	1,341	382	1,390	1,259	4,728
1992	373	1,408	401	1,460	1,322	4,964
1993	392	1,478	421	1,533	1,388	5,212
1994	412	1,552	442	1,610	1,457	5,473
1995	433	1,630	464	1,690	1,530	5,747

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	211	551	850	1,612
1987	221	579	893	1,693
1988	233	608	938	1,779
1989	244	639	984	1,867
1990	257	670	1,034	1,961
1991	269	704	1,086	2,059
1992	283	739	1,140	2,162
1993	297	776	1,197	2,270
1994	312	815	1,257	2,384
1995	327	855	1,320	2,502

Table D-17. Scenario IV--Sugar Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products			Total
	Urea	DAP	KCl	
	(mt)			(mt)
1986	1,785	1,145	2,070	5,000
1987	1,785	1,145	2,070	5,000
1988	1,785	1,145	2,070	5,000
1989	1,785	1,145	2,070	5,000
1990	1,785	1,145	2,070	5,000
1991	1,785	1,145	2,070	5,000
1992	1,785	1,145	2,070	5,000
1993	1,785	1,145	2,070	5,000
1994	1,785	1,145	2,070	5,000
1995	1,785	1,145	2,070	5,000

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	1,027	527	1,242	2,796
1987	1,027	527	1,242	2,796
1988	1,027	527	1,242	2,796
1989	1,027	527	1,242	2,796
1990	1,027	527	1,242	2,796
1991	1,027	527	1,242	2,796
1992	1,027	527	1,242	2,796
1993	1,027	527	1,242	2,796
1994	1,027	527	1,242	2,796
1995	1,027	527	1,242	2,796

Table D-18. Scenario IV--Tea Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products				Total
	AS	20-10-10	KCl	SSP	
	(mt)				(mt)
1986	459	652	35	11	1,157
1987	482	685	37	12	1,216
1988	506	719	39	13	1,277
1989	531	755	41	14	1,341
1990	558	793	43	15	1,409
1991	586	833	45	16	1,480
1992	615	875	47	17	1,554
1993	646	919	49	18	1,632
1994	678	965	51	19	1,713
1995	712	1,013	54	20	1,799

Year	Nutrients			Total
	N	P_2O_5	K_2O	
	(mt)			(mt)
1986	227	67	86	380
1987	238	71	91	400
1988	250	75	95	420
1989	263	78	100	441
1990	276	82	105	463
1991	290	87	110	487
1992	304	91	116	511
1993	319	96	121	536
1994	335	100	127	562
1995	352	105	134	591

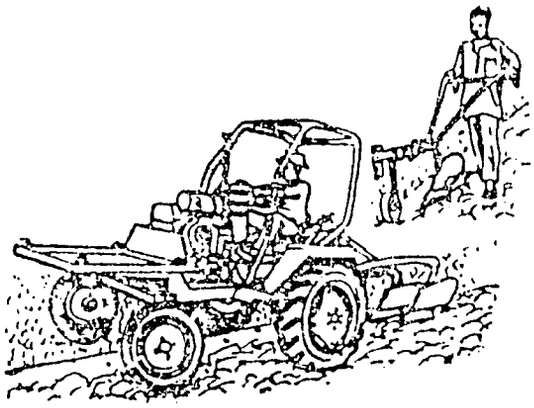
Table D-19. Scenario IV--Tobacco Projected Fertilizer Consumption With Recommended Marketing System and High Fertilizer/Crop Price Ratios

Year	Products			Total	Nutrients			Total
	AS	TSP	KSO_4		N	P_2O_5	K_2O	
	- - - - (mt) - - - - - -			(mt)	- - - - (mt) - - - - - -			(mt)
1986	16	32	11	59	3	15	6	24
1987	17	34	12	63	4	16	6	26
1988	18	36	13	67	4	17	7	28
1989	19	38	14	71	4	17	7	28
1990	20	40	15	75	4	18	8	30
1991	21	42	16	79	4	19	8	31
1992	22	44	17	83	5	20	9	34
1993	23	46	18	87	5	21	9	35
1994	24	48	19	91	5	22	10	37
1995	25	50	20	95	5	23	10	38

APPENDIX E

Crop Production Leaflets

COTON INTENSIF



- TRAITEMENT DES SEMENCES :

Si elles ne sont pas traitées depuis l'usine, mélanger 7 à 8 kg de semences avec le Gamoran mesuré dans une boîte de tomate pour 1 quart.

- VARIETE UTILISEE : IRCO 5028

TRAVAIL DU SOL

. Labour à la charrue (boeufs, ânes, tracteur)

. Passage croisé au Tiller ou dents de Canadien

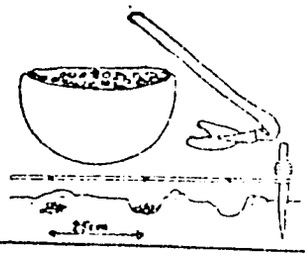
. Houage

- EPANDAGE D'ENGRAIS

. A la volée entre le labour et le hersage
. En localisé au semis en recouvrant les poquets

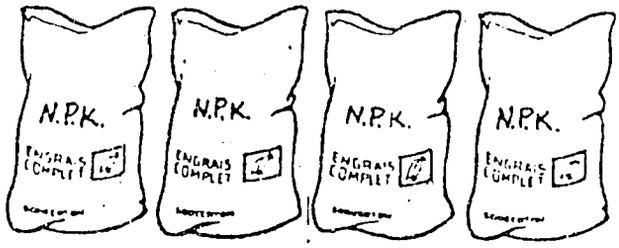
- SEMIS :

. en ligne à la corde avec repères
. 5 à 7 graines par poquet
. 80 cm entre les lignes
. 25 cm entre les poquets
. En ligne avec la houe bifide et épandage d'engrais



. Epoque de semis : 20 Mai - 30 Juin avant 20 juin impérativement pour la culture motorisée.

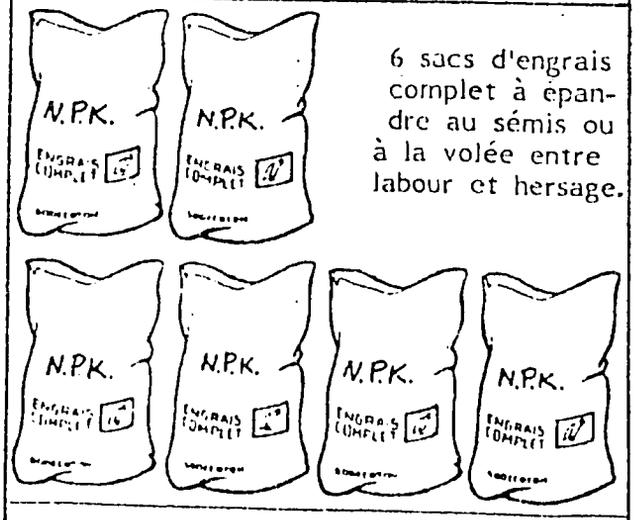
Dose normale pour 1 hectare



4 sacs d'engrais complet à épandre au semis ou entre le labour et le hersage

1 sac d'Urée à épandre 30 Jours après la levée au moment du buttage.

Dose renforcée pour un hectare



6 sacs d'engrais complet à épandre au sémis ou à la volée entre labour et hersage.

1 sac d'Urée à épandre 30 jours après la levée juste avant le buttage

..../....

REMPLIR CHAQUE JOUR LES CAHIERS DE CULTURE

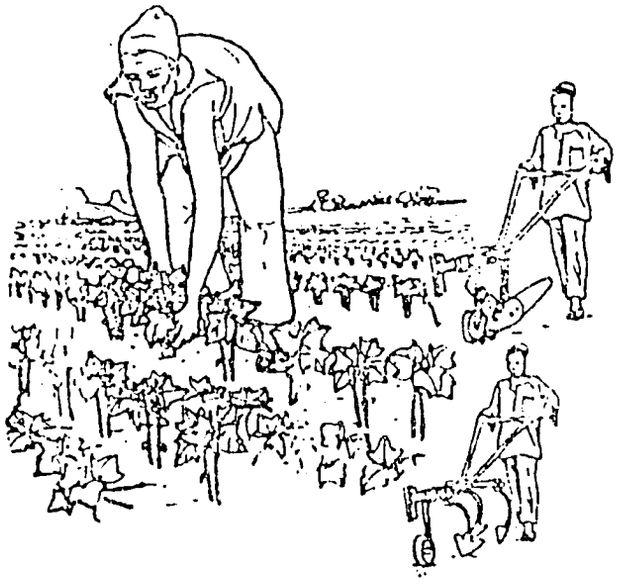
- HERBICIDE :

. Champ propre, bien labouré et hersé

. Utiliser l'appareil HANDY avec buse jaune

. Produits utilisés :
COTOFOR : 1 flacon de 0,75 l ou un flacon et demi de 0,5 l pour un quart.
COTODON: 1 flacon de 0,75 litre pour un quart.

. Traiter le jour du semis.



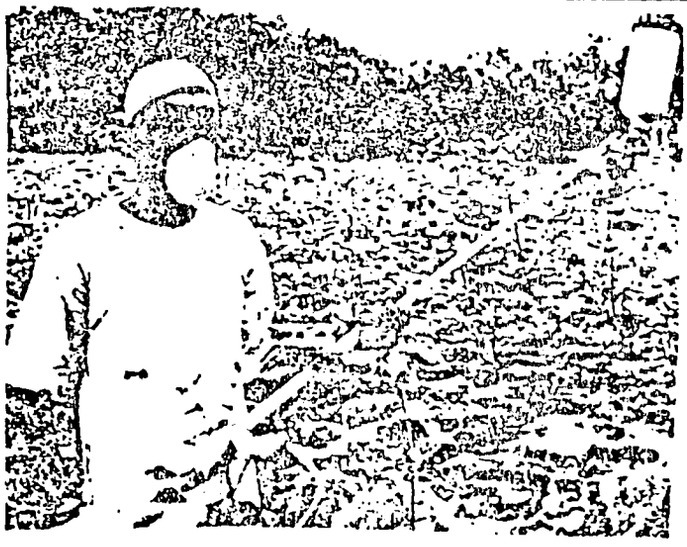
- ENTRETIEN :

. Démariage à 2 plants par poquet le sol étant humide (10 jours après la levée)

. Sarclage mécanique dès l'apparition des mauvaises herbes en ramenant la terre aux pieds des cotonniers.

• Buttage : corps butteur ou à la houe 30 à 40 jours après la levée

- TRAITEMENT INSECTICIDE :



. Dès l'apparition des boutons floraux après épandage d'Urée et buttage.

. Périodicité des traitements : tous les 10 Jours et l'alternance des produits combinés selon le calendrier établi avec le Chef de zône.

. Nettoyer les appareils après chaque traitement.

TRES IMPORTANT : Tenir constamment les cahiers de traitement à jour.

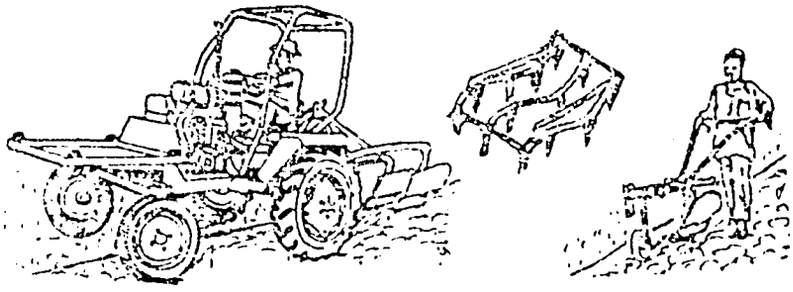
RIZ INTENSIF

- TRAITEMENT DES SEMENCES :

Pour 1 quart : 30 kg de semences
1 sachet de Thioral
Bien mélanger.

- VARIETES UTILISEES :

  - IRAT 110 ou IRAT 133 dans les Régions SEB et O.B.
  - IRAT 112 en multiplication et IRAT 113 dans la Région N.E.B.



- PREPARATION DU SOL

. Labour à la charrue (boeufs ou tracteur)

. hersage obligatoire

après épandage d'engrais et semis à la volée.

- SEMIS ET HERBICIDE

. Semis à la volée entre labour et hersage, remplir 3 fois la bouteille de diamaor pour semer 1 bande de 4 mètres de large.

. Semis en ligne avec le Semoir Casamance : 20 cm entre les lignes

. Traitement herbicide obligatoire le jour du semis.
Utiliser :
Appareil Handy avec buse jaune ,
AVIROSAN : 1 flacon de 0,75 l. pour 1 quart à mélanger avec l'eau suivant les instructions.

. Epoque de semis : du 15/06 au 20/07

N.B. : Pour les semis à la volée, le sarclage etant impossible il est indispensable de bien réussir le traitement herbicide.

- ENGRAIS ET ENTRETIEN DU CHAMP :

Dose normale pour un hectare	Dose renforcée pour un hectar
Epandre 2 sacs d'engrais entre le labour et le hersage à la volee.	Mélanger 2 sacs d'engrai + 1 sac d'Urée, épandre le teut à la volee entre labour et hersage
Epandre 1 sac d'Urée 30 jours après la levee.	1 sac d'Urée 30 jours après la levée.

SARCLAGE MANUEL OBLIGATOIRE DES L'APPARITION DES HERBES.

TRES IMPORTANT : TENIR CONSTAMMENT A JOUR LES CAHIERS DE CULTURES VIVRIERES

FORMATION AGRICOLE

SORGHO DE PLUIE A CYCLE COURT

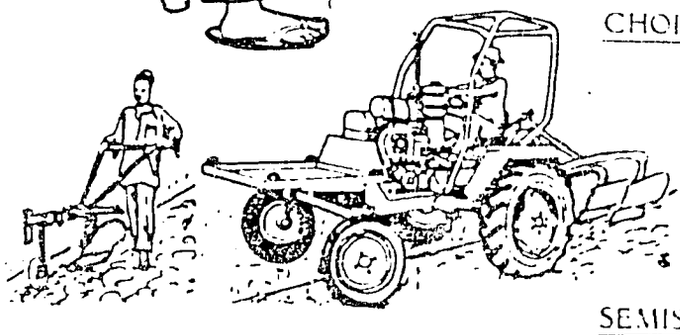
INTRODUCTION DE NOUVELLES VARIETES

VARIETES UTILISEES :

Province de l'Extrême-Nord : 38.3
Région Mayo-Louti : E 35-1 et 38.3

TRAITEMENT DES SEMENCES :

Pour semer 1 quart 5 kg de semences.
Bien mélanger avec ½ sachet de THIORAL



CHOIX ET PREPARATION DU SOL :

- Semer sur précédent cultural coton
- Bien nettoyer le sol, les vieux cotonniers ayant été coupés et brûlés au moment de la récolte
- Le labour est obligatoire
- Ane, boeufs, tracteur

SEMIS :

Date de Semis :

- du 25 Juin au 20 Juillet pour la 38.3
- du 15 Juin au 15 Juillet pour la E 35-1 après une bonne pluie.

Semer 8 à 10 graines/poquet à une profondeur de 1 à 1,5 cm.

80 cm entre les ligne, 40 cm entre les poquets

HERBICIDE : SORGHOPRIM à 2,5 litres/ha appareil HANDY buse jaune.

ENTRETIEN :

Démariage à 2 plants/poquet, 3 semaines après le semis le sol étant humide.

Epandage d'urée obligatoire

- Epandage d'urée : 1 quart de sac pour 1 quart juste avant le buttage 30 jours après la levée.
- Urée vendue au comptant.
- 1 litre d'Urée pour 4 lignes.

TRES IMPORTANT : TENIR CONSTAMMENT A JOUR LES CAHIERS DE CULTURES VIVRIERES

SORGHO DE PLUIE AMELIORE

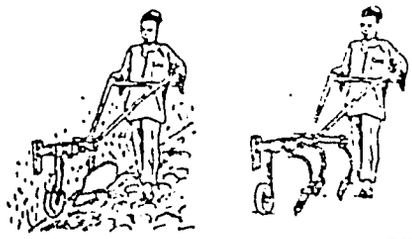
VARIETES UTILISEES :

Province de l'Extrême-Nord : 38.3
Région Mayo-Louti et Mayo-Danay : E 35-1

TRAITEMENT DES SEMENCES :

Pour semer 1 quart 6 kg de semences. Bien mélanger avec ½ sachet de Thioral.

CHOIX ET PREPARATION DU SOL :



. Semer sur précédent cultural coton
. Bien nettoyer le sol, les vieux cotonniers ayant été coupés et brûlés au moment de la récolte labourer ou faire 2 passages croisés à la charrue équipée de dents de "Canadien".

SEMIS :

. Date de Semis :

. du 25 Juin au 20 Juillet pour la 38.3

. du 15 Juin au 15 Juillet pour la E 35-1 après une bonne pluie.

Semer 8 à 10 graines/poquet à une profondeur de 1 à 1,5 cm.

80 cm entre les ligne, 40 cm entre les poquets

HERBICIDE : SORGHOPRIM à 2,5 litres/ha appareil HANDY buse jaune.

ENTRETIEN :

Démariage à 2 plants/poquet, 3 semaines après le semis le sol étant humide.

Nous conseillons fortement d'épandre l'Urée.

. Epandage d'Urée : 1 quart de sac pour 1 quart juste avant le buttage 30 jours après la levée.

. Urée vendue au comptant.

. 1 litre d'Urée pour 4 lignes.

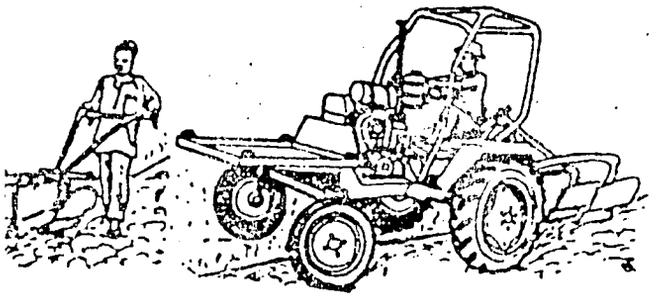
TRES IMPORTANT : TENIR CONSTAMMENT A JOUR LES CAHIERS DE CULTURES VIVRIERES

SODECOTON
FORMATION AGRICOLE

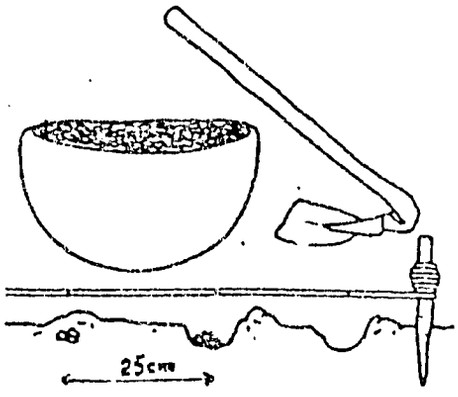
N° 8/AG/85

CULTURE INTENSIVE DU MAÏS

- TRAITEMENT DES SEMENCES :
  - Pour un quart, 7 à 8 kg de semences.
  - Remplir 10 fois une bouteille vide de Diamaor.
  - Bien mélanger avec ½ sachet de Thioral.
- VARIETES UTILISEES :
  - TZPB dans toute la Région SEB ainsi que les Secteurs Poli et Ngong.
  - MEXICAN 17 E dans les Régions NEB et Mayo-Louti ainsi que le Secteur Hamakoussou



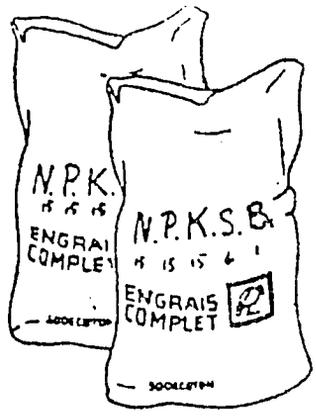
- PREPARATION DU SOL :
  - Eviter les terrains legers et mal drainés
  - Labour et hersage



- SEMIS :
  - Semis entre le 15 Juin et 10 Juillet
  - En ligne à la corde à repères
    80 cm entre deux lignes
    25 cm entre deux poquets
    2 à 3 graines par poquet.
- HERBICIDE : Appareil HANDY avec buse Jaune
  Pour un quart, utiliser un flaçon de 1 litre de PRIMEXTRA ou LASSO mélangé à 1,5 litre d'eau

- ENGRAIS :

formule normale



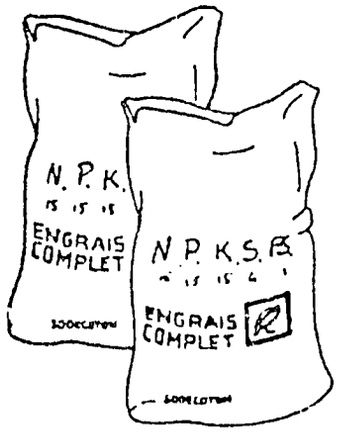
+

Mélanger 2 sacs d'engrais + 1 sac d'Urée épandre ce mélange dans 1 hectare au moment du semis ou à la volée entre labour et hersage.

30 jours après la levée, épandre 1 sac d'Urée pour 1 ha au moment du buttage.

- ENGRAIS :

Formule renforcée



+

au semis même dose que pour la formule normale.

2 sacs d'Urée pour 1 ha 30 jours après la levée au moment du buttage.

- ENTRETIEN DU CHAMP :

. Démariage à 1 plant dès la levée après une pluie.

. Sarclage dès l'apparition des mauvaises herbes : ensemble sarcleur ou à la houe.

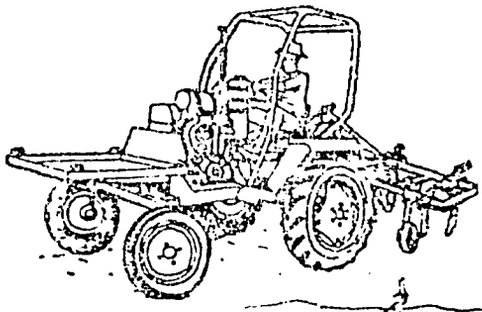
. Buttage 30 jours après la levée au moment de l'épandage d'Urée.

TRES IMPORTANT : TENIR CONSTAMMENT A JOUR LES CAHIERS DE CULTURES VIVRIERES

CULTURE ASSOCIEE MAÏS - SORGHO

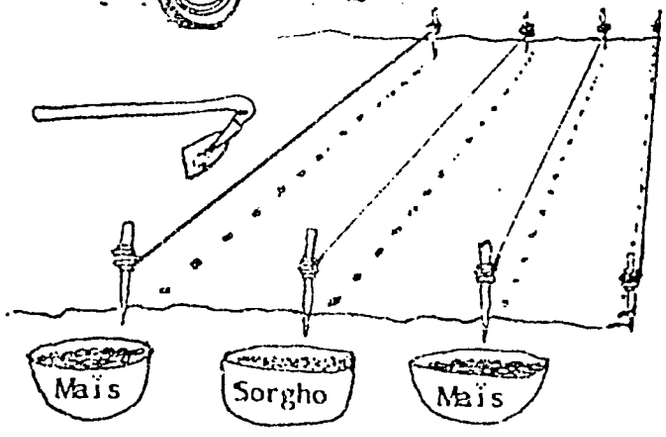
- TRAITEMENT DES SEMENCES :

. Pour semer 1 quart
. mélanger : 1/4 sachet de Thioral
4 kg de semence maïs
. mélanger : 1/4 sachet de Thioral
3 kg de semence sorgho



- PREPARATION DU SOL :

. Dès les premières pluies
. Double passage croisé au Tiller attelé au tracteur.



- SEMIS ET HERBICIDE

. Semis en ligne
. 80 cm entre deux lignes
. 25 cm entre deux poquets
. 2 à 3 graines par poquet de maïs
. 5 à 6 graines par poquet de sorgho
. Alternez : - 1 ligne sorgho
- 1 ligne maïs
. Traitement herbicide le jour du semis ou le jour suivant
. HANDY avec buse jaune
. 1 flacon de Sorghoprim 0,625 litre/quart + quantité d'eau prescrite.

- ENTRETIEN ET FUMURE :

. Démariage : à 1 plant le maïs
3 plants le sorgho
. Buttage : avec le corps butteur
. Epandage d'Urée localisé au pied de chaque poquet au moment du buttage.

Pour 1 hectare : 100 kg d'urée

TRES IMPORTANT : TENIR A JOUR LES CAHIERS DE CULTURE

NIEBE

- VARIETES :

TVX 32 36
IFE BROWN

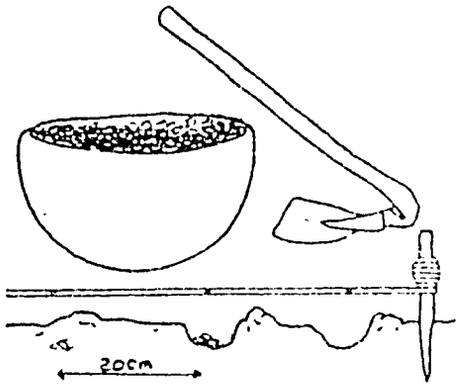
- TRAITEMENT DES SEMENCES :

20 kg de semences bien traités suffisent pour 1 ha
Bien mélanger avec 1 sachet de THIORAL.

- PREPARATION DU SOL

Choisir un sol bien drainé

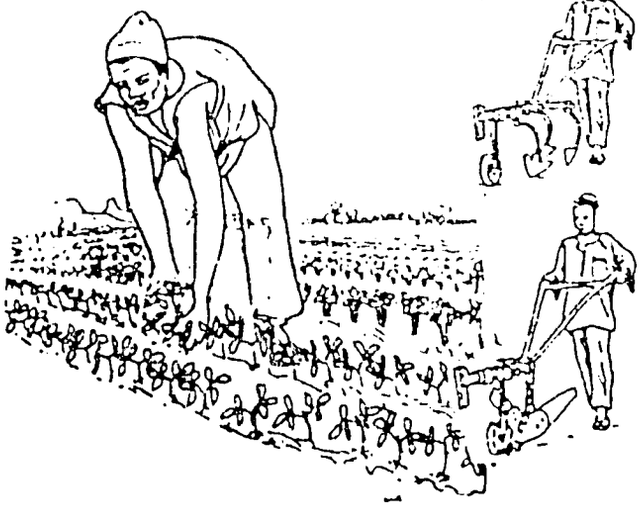
Labour à la charrue puis hersage.



- SEMIS :

Semis en ligne à 80 cm entre les lignes
20 cm entre les poquets
2 à 3 graines par poquet

Date de semis : entre le 5 et le 15 Juillet.



- ENTRETIEN :

Démarriage à 1 plant 20 jours après les semis après une pluie

Sarclage : aussitôt que les herbes apparaissent
Pas d'engrais ni d'urée.

Buttage : entre le 20e et 40e jour après le semis.

- TRAITEMENTS INSECTICIDES :

. Effectuez 3 traitements avec un produit composé à la même dose par hectare que pour le coton.

35 Jours après le semis pour le 1er traitement
45 Jours après le semis pour le 2e traitement
55 Jours après le semis pour le 3e traitement

. Produits Utilisés :

Fûts rouges 2 l/ha
- Polytrine C 165, Decis Triazophos 6-125
- Cymbush-Dimethoate 15-2

Fûts verts 1 l/ha
- Cymbush Dimethoate 30-4
- Decis-Triazophos 9.250

TRES IMPORTANT : TENIR CONSTAMMENT A JOUR LES CAHIERS DE CULTURES VIVRIERI

CHEFS SCE ASS. R.
FORMATEURS REGION.
CFA GUETALE.

NOTE DE SERVICE N° 027/85/DG/MI/PK
CONCERNANT LE MONTANT DES FORFAITS DE CULTURE INTENSIVE
CAMPAGNE 1985/1986

Culture	Nature du forfait	Montant par ha	Montant par quart
Coton	Traitement insecticides	2 000	500
. Fumure zone Nord	100 NPKSB (22.10.[illegible].1)	12 000	3 000
	200 NPKSB (22.10.1[illegible].1)	24 000	6 000
. Future zone Sud	200 NPKSB + 50 Urée	30 000	7 500
	300 NPKSB + 50 Urée	43 000	10 750
Arachide	100 Phosphate	14 000	3 500
	100 semences	16 000	4 000
	Location semoir	2 000	500
Maïs	100 NPKSB + 100 Urée	21 000	5 250
	100 NPKSB + 150 Urée	25 000	6 250
	30 semences	3 600	900
Riz pluvial	100 NPKSB + 50 Urée	17 000	4 250
	100 NPKSB + 100 Urée	21 000	5 250
	120 semences	12 000	3 000
Sorgho (1)	50 Urée	4 000	1 000
	20 semences	p. m.	p. m.
Niébé (1)	Traitement insecticides	1 000	250
	20 semences IVK 32-36	p. m.	p. m.
	8 sec + trayicyde.	5 600	1 400

Le coût du traitement herbicide est fixé à 3 000 francs par hectare et ce pour toutes les cultures.

Les semences sorgho et niébé seront distribuées à crédit avec restitution d'une quantité double par le planteur à la récolte.

Les 20 kg de semences de niébé variété IVK 32-36 sont ramenés à 10 kg (par hectare) s'il s'agit de la variété Vigna.

Les tarifs ci-dessus, qui tiennent compte des subventions SODECOTON, ne concernent que les cessions au bénéfice des planteurs encadrés par la SODECOTON et travaillant selon ses recommandations.

Les éventuelles demandes d'autres clients doivent impérativement être transmises à la D.D.R. pour étude et ne peuvent bénéficier de subvention.

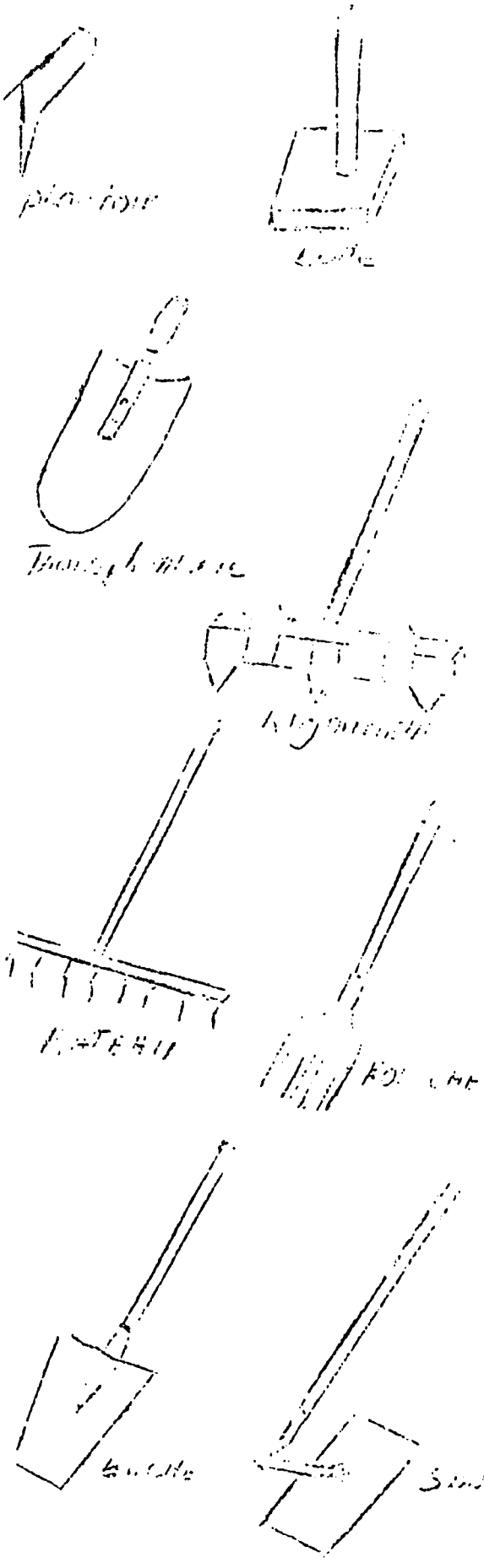
Garoua, le 7 Mai 1985
Le Directeur Général

M. [illegible]

N.0/

DELEGATION PROVINCIALE DE L'AGRICULTURE DE L'EXTREME-NORD SERVICE PROVINCIAL DE L'AGRICULTURE.

F I C H E S T E C H N I Q U E S (1)



I. LES PRINCIPAUX OUTILS DU MARAICHER

I.1. LES OUTILS QU'IL PEUT FABRIQUE LUI MEME

- LE PLANTOIR SERT A REPIQUER LES JEUNES PLANTS
- LA BATTE SERT A TASSER LE SOL APRES LE SEMIS
- LA CORDE OU CORDEAU SERT A TRACER DES LIGNES DROITES POUR SEMER ET REPIQUER.
- LE REYONNEUR PERMET DE TRACER PLUSIEUR LIGNES A LA FOIS SUR UNE PLANCHE
- LE RATEAU SERT A CASSER LES MOTTES, A FAIRE LES PLANCHES BIEN PLATES A, A RECOUVRIR DE TERRE LES GRAINES SEMEES.

I.2. LES OUTILS QUE LE MARAICHER DOIT ACHETER.

- LA BECHE : SERT A RETOURNER LA TERRE
- LA FOURCHE BECHE : SERT A RETOURNER LA TERRE QUAND LE SOL EST ARGILEUX OU CONTIENT BEAUCOUP DE CAILLOUX.
- LE CROC : SERT A LABOURER EN TERRE EN PROFONDEUR ET RETIRER LES RACINES.
- LE SARCLOIR : COUPER LES MAUVAISES HERBES ET A BINER ENTRE LES LIGNES DE CULTURE.
- L'ARROSOIR : SERT A ARROSER LES LEGUMES SANS LES ABIMER.
- BROUETTE : TRANSPORT DU FUMIER, COMPOST, ENGRAIS, HERBE ETC...
- TRANSPLANTOIR SERT A ENLEVER LES JEUNES PLANTS AVEC LA MOTTE DE TERRE QUI ENTOURE LES RECINES.

DELEGATION PROVINCIALE DE L'AGRICULTURE DE L'EXTREME-NORD SERVICE PROVINCIAL DE L'AGRICULTURE

F I C H E S T E C H N I Q U E S

II

NOTIONS GENERALES

CHOIX DU TERRAIN

- LE TERRAIN DOIT ETRE CHOISI : A PROXIMITE D'UN POINT-D'EAU (PUIT A FAIBLE PROFONDEUR POUR FACILITER L'ARROSAGE OU L'IRRIGATION).
- PROXIMITE D'UN MAYO
- SUR UN BON SOL : QUI N'EST NI TROP SABLEUX, NI TROP ARGILEUX.

PREPARATION DU TERRAIN

- NETTOYER LE TERRAIN
- DELIMITER LA PARCELLE SUIVANT UNE FORME REGULIERE (rectangle ou carré)
- PIOCHER A 20 cm DE PROFONDEUR SUR TOUTE LA SURFACE,
- ENLEVER LES PIERRES ET LES SOUCHES.

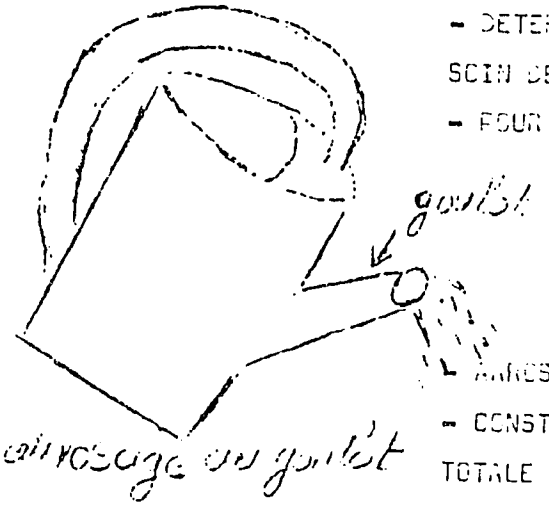
PEPINIERE

- LABOURER PROFONDEMENT A L'AIDE DE LA PIOCHE (20 A 25 cm EN SOL SABLEUX, 35 A 40 cm EN SOL ARGILEUX)
- CASSER LES MOTTES ET AMEUBLIR AU CROC BECHE
- ENFOUIR DU FUMIER
- EMIETTER AFFINER ET APPLANIR LA COUCHE SUPERFICIELLE AU RATEAU
- AVANT DE SEMER, DESINFECTER LE SOL DE LA PEPINIERE AVEC DE L'EAU BOUILLANTE (environ 1 A 2 arrosoir/m2)
- SEMER EN LIGNE (ne pas enfoncer les semences dans le sol)
- RECOUVRIR LE LIT DE SEMENCE AVEC UN PEU DE TERRE TRES FINE, PLOMBER LEGEREMENT A LA BATTE, ET ARROSER LEGEREMENT A LA POMME D'ARROSOIR.
- CONSTRUIRE UNE OMBIERE POUR PROTEGER LES SEMIS ET LES JEUNES PLANTS DU SOLEIL.
- ARROSER REGULIEREMENT (matin et soir : 1 arrosoir/m2)
- QUAND LES JEUNES PLANTS COMMENCENT A POUSSER, ENLEVER PEU A PEU L'OMBRAGE ET DEMARIER, POUR AVOIR DES PLANTS VIGOUREUX ET ASSURER UN BON TAUX DE REPRISE AU REPIQUAGE EXEMPLE : 1000 PLANTS/m2 POUR LES LIGNES 300 PLANTS/m2 POUR LES TOMATES.

.../...

REPIQUAGE:

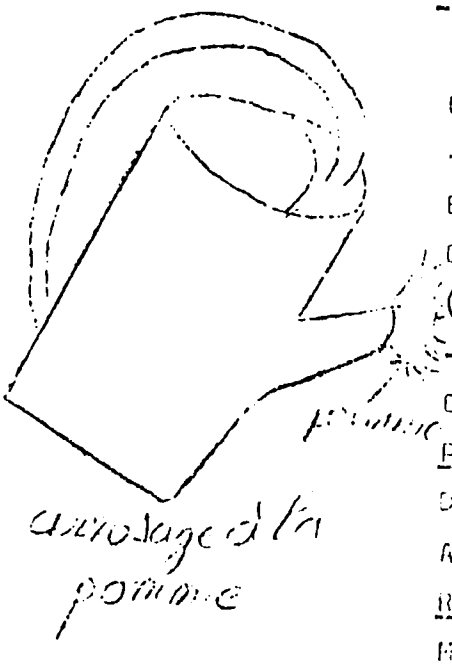
- LE REPIQUAGE DOIT AVOIR LIEU DE PREFERENCE LE SOIR, (LA FRAICHEUR DE LA NUIT AIDANT A LA REPRISE)
- BIEN ARROSER LA PEPINIERE AVANT DE PRELEVER LES JEUNES PLANTS POUR LE REPIQUAGE.
- CHOISIR LES PLANTS VIGOUREUX
- DETERRER LES PLANTS A L'AIDE D'UN TRANSPLANTOIR EN PRENANT SOIN DE CONSERVER LES MOTTES AUTOUR DES RACINES.
- POUR LA MISE EN PLACE, - FAIRE UN TROU AVEC LE PLANTOIR
  - ENFONCER LE PLANT PREPARE JUSQU'AU NIVEAU DU COLLET
  - TASSER LA TERRE TOUT AUTOUR DU PLANT.



- ARROSER AU GOULOT DE L'ARROSOIR ENTRE LES LIGNES
- CONSTRUIRE UN ABRI AU DESSUS DES PLANCHES JUSQU'A LA REPRISE TOTALE DES PLANTS.

PREPARATION DES PLANCHES :

- PREPARER DES PLANCHES DE 1,20 m DE LARGE ET DE LONGUEUR VARIABLE. - LAISSER ENTRE LES PLANCHES UNE ALLEE DE 20cm DE LARGE POUR FACILITER LE PASSAGE
- POUR PREPARER LA PLANCHE, MATERIALISER A L'AIDE DU CORDEAU ET DES PIQUETS, PUIS, ENFONCER A L'AIDE DE LA PIOCHE OU DU CROC BECHE 25cm DE PROFONDEUR ET ENFOUIR DU FUMIER OU COMPOST (ENVIRON DEUX BROUETTES/10m2)
- ATTENTION : NE PAS ENFOUIR DU FUMIER LORSQU'IL S'AGIT DES CULTURES SUIVANTES : OIGNONS, CAROTTES, MAIS, AIL



PROTECTION PHYTOSANITAIRE: POUR TOUTE ATTAQUE DE MALADIE OU D'INSECTE, ALERTER IMMEDIATEMENT LE MONITEUR AGRICOLE QUI FAIT APPEL A LA BRIGADE PHYTOSANITAIRE

ROTATION DES CULTURES:EN CAS DE SUCCESSION DES CULTURES SUR LA MEME PLANCHE, LA MARAICHER NE DOIT PAS CULTIVER A LA SUITE DES LEGUMES DE LA MEME FAMILLE, CAR ILS SOUFFRENT DES MEMES MALADIES, DES MEMES ELEMENTS DANS LE SOL LE TABLEAU SUIVANT REGROUPE LES LEGUMES DE LA MEME FAMILLE, QUI NE DOIVENT DONC PAS SE SUCCEDER SUR LE MEME TERRAIN OU LA MEME PLANCHE.

.../...

REPUBLIQUE DU CAMEROUN
PAIX - TRAVAIL - PATRIE

MINISTERE DE L'ENSEIGNEMENT SUPERIEURE
ET DE LA RECHERCHE SCIENTIFIQUE

REPUBLIC OF CAMEROON
PEACE - WORK - FATHERLAND

MINISTRY OF HIGHER EDUCATION
AND SCIENTIFIC RESEARCH

INSTITUT DE LA RECHERCHE AGRONOMIQUE

I. R. A.

INSTITUTE OF AGRONOMIC RESEARCH

TECHNICAL BULLETIN -- N° I/84/IRA/BAMBUI

HOW TO GROW MAIZE FOR HIGH YIELDS

FIRST REVISION: by the TLU/NCRE
Original document (1980)

Prepared by,

Mr. Edward Ngong-Nassah
with Technical Assistance by
Dr. JACOB ASSAM AYUK-TAKEM.

C O N T E N T S

		PAGE
1.	INTRODUCTION	1
2.	LAND PREPARATION	2
	2.1 SOIL SELECTION	2 - 3
	2.2 LAND PREPARATION	3 - 4
3.	PLANTING MATERIAL	4
	3.2 IMPROVED MAIZE VARIETIES	4 - 5
	3.2 SEED SELECTION	5
4.	PLANTING	5
	4.1 DATE OF PLANTING	5 - 6
	4.2 QUANTITY OF SEED	6
	4.3 PLANT SPACING	6
	4.4 DEPTH OF PLANTING	6
5.	MIXED OR INTERCROPPING OF MAIZE	7
6.	FERTILIZER USE ON MAIZE	7
	6.1 TYPE OF FERTILIZER	7 - 8
	6.2 RATE, TIMING AND METHOD OF APPLICATION .. .	8 -10
7.	W E E D I N G	10
	7.1 ADVANTAGES OF WEEDING	10
	7.2 METHODS OF WEED CONTROL	11
8.	DISEASE AND PEST CONTROL	11
	8.1 CORN STALK BORER	11
	8.2 MAIZE DISEASES	12
9.	H A R V E S T	12
	9.1 DATE OF HARVEST	12
	9.2 HARVEST METHODS..	13
10.	S T O R A G E	13
	10.1 STORAGE METHODS	13
	10.2 CHEMICALS USED FOR STORING MAIZE	13 - 14
11.	ECONOMICS (COSTS AND RETURNS) OF GROWING MAIZE .	14 - 15.

I N T R O D U C T I O N

Maize is a staple food for a majority of Cameroonians. It is eaten in various forms (e.g., roasted green, patched dry, foofoo, alcoholic beverage, etc.) and is used as animal feed (poultry, pigs, etc.).

Cameroon produces about 500,000 metric tons of maize grain annually over 80% of this coming from the North-West, Western, Littoral and South West Provinces.

Maize can be produced throughout the year. In the forest zone of Cameroon and in parts of the savannah zone, two crops are possible, with plantings in March and in August.

A great deal of maize research has been done in Cameroon, particularly in the area of maize breeding. By the year 1980, over 10 improved maize varieties had been developed by IRA BAMBUI. Comparatively less work has been done on maize agronomy (i.e., cultural practices).

In 1981, the National Cereals Research and Extension (NCRE) Project began an intensive program of breeding, agronomy and farming systems (on-farms) research with maize, rice, sorghum and millet. Working in con cert with a Plant Physiologist and Phytopathologist at IRA BAMBUI, the NCRE research team has made significant advances toward identifying packages of recommended maize varieties and practices for use by small scale peasant farmers.

The present technical bulletin is a revision of Technical Bulletin N° I/80/IRA/BAMBUI, originally prepared by Mr. Edward Ngong-Nassah (Extension Agronomist, IRA-BAMBUI) with the technical assistance of Mr. (Now Dr.) Jacob Assam AYUK-TAKEM (Senior Maize Breeder for MESRES, Coordinator of the National Cereals Research and Extension Project, Head of the IRA Cereals Program and Chief of Station IRA Bambui). The revision borrows heavily from the original document, updating figures where needed, and supplementing with new information where such information is available.

TESTING AND LIAISON UNIT

2. LAND PREPARATION

2.1 SOIL SELECTION:

Maize can be grown on a wide variety of soils, but does best on soils that are:

(1) Well Drained and aerated.

- A well drained soil is able to get rid of excess water and is affected by texture, structure and the existence of hardpans or other impermeable layers.
- Roots require oxygen, which is present in well aerated soils, but absent in water-logged soils, in order to absorb water and nutrients.
- Finally the maize crop is highly sensitive to excess soil moisture conditions particularly during the seedling stage. Plant stand is reduced considerably and plant growth is retarded to such an extent that the reduction in yield, with excess soil moisture conditions for a period of (3) three to six days can amount to about 30 to 50 percent. It is therefore very important that the soils in which maize is grown are well drained.

(2) Deep Warm Loams or Silt Loams (medium texture soils).

- Finer texture soils (clays) have a higher nutrient holding capacity, but are difficult to work and are often plagued by drainage and erosion problems.
- Medium texture soils (loams) are easier to work, have a higher available-water holding capacity and drain better than clays. They are typically more fertile than coarser sandy soils.
- Coarse texture soils (sandy soils) are characterized by low water holding and nutrient holding capacity, good drainage and increased (root) lodging of maize plants.

(3) Abundant in Organic Matter (OM).

Soil organic matter (usually 2 - 6% of mineral soils) improves soil condition as follows:

- Improves soil physical properties (soil aggregate formation).
- Provides plant nutrients (maize yields increase 600 kg/ha for each additional 1% of OM in topsoil).
- Increases the nutrient and water holding capacity of the soil.

(4) Well supplied with Nutrients.

A three (3) ton crop of maize extracts the following nutrients from the soil:

N	=	84	kg	Ca	=	15.5	kg
P_2O_5	=	32	kg	Mg	=	13.4	kg
K_2O	=	66	kg	S	=	9.0	kg

(5) Near Neutral in Soil Acidity (I.e., pH 6.0 - 7.0).

- Beneficial soil microbes thrive in the neutral pH range.
- Phosphorous is most available to the maize plant between PH 6.0 and 7.0
- Micronutrient availability is affected greatly by soil pH.

2.2 SOIL PREPARATION:

Many varied land clearing and soil preparation methods are practised in Cameroon. Insufficient research has been conducted to date for iron-clad rules to be laid down on the matter. Although slashing and burning approaches are known to be destructive of the organic matter and ultimately the structure and fertility of the soil; it is a sobering fact that manual clearing can take up to 200 man-days per hectare, valued at 200,000 francs CFA.

Having cleared the land, the next important operation is tilling the soil. By tillage is meant any form of turning, loosening, cultivating and compacting the soil. The role of tillage in crop production is:

- To break up clods into smaller aggregates and loosen the soil to form a good, deep seedbed.
- To turn under (bury) crop residues and weeds, which decompose and add to the soil organic matter.
- To improve aeration and water movement into the soil (infiltration).
- To destroy (bury) weeds and insect pests.

While tilling, the soil is often formed into ridges, big or small. If done on sloping land, it is important that the ridges be made across (perpendicular to) the slope (contour ridging) to minimize soil erosion. Other methods of erosion control include:

- Strip cropping (alternating bands of erosion susceptible and erosion resisting crops).
- Terracing.
- Tied Ridges (cross bars between ridges).

3. PLANTING MATERIAL

3.1 IMPROVED MAIZE VARIETIES:

Several improved maize varieties have been developed and extensively tested by IRA. In particular, a number of mid and low altitude varieties have been tested in farmers' fields under joint researchers' and farmers' management. A short list of improved varieties with a brief description of each follows.

VARIETY	Yields On-Farms	Description
-Mid to High Altitudes (800 masl):		
COCA	4.1 tonnes/ha	White, Flinty-Dent, Long-cycle (150 da
SAW	4.3 tonnes/ha	White, Dent, Long-cycle.
POLYHYBRID 290	4.0 tonnes/ha	White, Dent, Long-cycle.
M L C	4.1 tonnes/ha	White, Dent, Long-cycle.
BACOA	4.4 tonnes/ha	Yellow, Flinty-Dent, Short-cycle (120 days)
-Low Altitude (800 masl)		
EKONA WHITE	5.8 tonnes	White, Dent, Long-cycle (120 days).
EKONA YELLOW	4.3 tonnes/ha	Yellow, Dent, Long-cycle (120 days).

Improved maize seed is usually available to farmers through the extension office (MIDENO-NWP & UCCAO-WP).

In research plots, grain yields of 6 to 10 tons/ha have been obtained for the above mentioned varieties developed by IRA. Most of them are good for making foufou.

3.2 SEED SELECTION.

If a farmer choses to select and plant his/her own seed, the following advice should be kept in mind.

- Select seed from mature, healthy (disease free) plants.
- Seed should be plump, not shrivelled, and of the desired colour.
- Stored seed should be free from broken grains, weevils and rotten or mouldy grains.
- Protect the viability of the seed. Don't overheat when drying or store in air tight plastic containers.
- Preserve seed in a cool, dry, well ventilated place to avoid deterioration.
- Keep treated seed maize separate from food maize.

Seed from improved varieties, that are not hybrids, can be saved by the farmer through 2 to 3 crops. After that, the farmer should obtain fresh seed of the improved variety from the extension office. The seed of hybrid varieties must be renewed every year. The varieties listed above (section 3.1) are all open-pollinated varieties (not hybrids).

4. PLANTING

4.1 DATE OF PLANTING:

In the North-West and West Provinces, the first season maize is typically planted in March or early April; or as soon as the rains have started. A second season maize crop is grown in some areas, notably in Bali and Kom subdivisions in the North-West Province. The late crop is normally planted in July or August. Date of planting trials carried out at three different altitudes (700, 1500 and 1800 masl) indicate that at lower elevations, the late crop can be planted as early as the first week of July; whereas, at higher elevations it is advisable to wait until early to mid August. Late season crops often

.../.

don't do as well as first season maize, because of a higher incidence of corn stalk-borers and various diseases.

4.2 QUANTITY OF SEED.

The amount of maize seed required for planting depends on whether the maize is to be grown sole or in association with other crops.

For a sole crop with a maize plant population of 50,000 plants per hectare, 20 to 25 kg of seed per hectare is needed.

If intercropped with another crop (e.g., groundnuts or beans), the quantity of seed needed will be somewhat lower.

4.3 SPACING OF PLANTS.

For sole - cropped maize, the recommended spacing is 25 × 80 cm i.e., 25 cm between plants within the row and 80 cm between rows. One plant per hill is retained. In some cases (e.g., when planting on large, or unevenly spaced ridges, it is difficult to respect the row spacing. In that case, an attempt should be made to at least maintain a plant population of between 50,000 and 55,000 plants per hectare.

When intercropping with a low growing crop, such as beans or groundnuts, the within row spacing can be increased from 25 cm to 50 cm between plants. One or two maize plants per hill can be retained, depending on the height and leafiness of the maize variety being planted. Tall, leafy varieties will tend to shade the beans or groundnuts, depressing their yields; and therefore should be planted at only one plant per hill.

4.4 DEPTH OF PLANTING.

Maize should not be planted too deep nor too shallow. Seed planted too deeply will germinate, but the seedling may never reach the surface to receive sunlight.

If Planted too shallow, it may be washed away by the rain, or dug up and eaten by rodents and birds.

Maize seed should be planted at a depth of between 5 and 7 cm, just about as deep as the length of a forefinger.

5. MIXED OR INTERCROPPING OF MAIZE:

It is rare in Cameroon to find maize grown as a sole crop. Reasons often advanced for intercropping of maize include:

- efficiency of land use (supported in many cases by research work),
- avoidance of risk (i.e., reducing the potential loss to the farmer should the maize crop fail), and
- effective use of farm labor.

The most common disadvantage cited is the relative low yields in comparison to sole - cropped maize.

Insufficient research has been done in the past with regards to maize based crop associations. IRA is presently engaged in a program of farming systems research that is meant to provide the missing information.

However, it is safe to say that in associating maize with another crop(s) one should,

- avoid climbing plants e.g., climbing beans or yams,
- avoid growing maize under heavy shade e.g., tree crops, coffee, etc.,
- avoid growing maize in mature coffee or cocoa farms, because in cultivating the maize the roots of the coffee or cocoa can be damaged, reducing their yields.

Maize grown in association with dwarf (bush) beans, groundnuts, cowpeas or soybeans has been proven to be a good cropping practice.

6. FERTILIZER USE ON MAIZE:

6.1 TYPE OF FERTILIZER.

Maize responds well to the use of fertilizer on all but the most fertile soils. Three nutrients in particular are important to maize i.e., Nitrogen, Phosphorous and Potassium.

Nitrogen (N) is needed for good vegetative (leaf and stalk) growth, and is the most important of the three major nutrients. Peak demand for Nitrogen in maize is between 3 weeks before tasseling and 2 weeks after tasseling. Because Nitrogen is easily lost from the soil by leaching (i.e., washed out by the rain), it is usually applied in two (split) applications.

.../.

Phosphorous (P) plays an important role in root development, stalk strength and grain formation. It is fixed in the soil, and can therefore be applied all at planting time, with no fear of loss by leaching.

Potassium (K) influences the general vigor of plants and is important for root growth, stalk strength and disease resistance. As with Phosphorous, Potassium is not readily leached from the soil, and can therefore be applied all at planting time.

A number of other so-called micro-nutrients are also required by maize, but in much smaller quantities (e.g., Sulfur, Magnesium, Calcium, Zinc, etc.). These secondary nutrients are usually present in sufficient quantities in the soil, and only rarely have to be supplemented with fertilizers

Ideally, there should be a fertilizer with the appropriate proportions of the three major nutrients (N, P and K) for use on maize, and which would be readily available to farmers. However, in reality the only fertilizers available to farmers are two fertilizers distributed through coffee cooperatives for use on coffee. These are 20-10-10 compound fertilizer and ammonium sulphate.

The 20-10-10 contains 20% N, 10% P_2O_5 (a form of P) and 10% K_2O. Ammonium-sulphate contains 20.5% N and Sulfur, only. Both sell for about the same subsidized price (2000 CFA per 50 kg bag in 1984).

Given the limited choice open to farmers in deciding which fertilizer to use, and the known acidifying effect of ammonium sulphate on soils, 20-10-10 is the obvious candidate for use on maize, at least at the present time.

6.2 RATE, TIMING AND METHOD OF APPLICATION:

RATE: The amount (rate) of fertilizer required by maize depends on the fertility of the soil. On some soils maize will respond very well to even heavy rates of fertilizer. On other soils there is very little response.

On average, on-farm maize trials throughout the North-West and West Provinces have shown that maize (particularly improved varieties of maize) responds well to a moderate

.../

rate of fertilizer on the majority of soils encountered. If a farmer intends to plant an improved variety of maize, he/she should apply fertilizer to make the most effective use of the high yielding potential of such varieties.

A moderate rate of fertilizer would be between 250 to 300 kg (5 to 6 bags) of 20-10-10 compound fertilizer per hectare. This is equivalent to 5 to 6 grams (or one beer bottle cap full) of 20-10-10 fertilizer per maize plant, when planted as a sole crop.

Fertilizer response trials using 20-10-10 on maize have shown that as much as 600 kg per hectare can be profitably applied to maize, when grown as a sole crop. However, if capital is limited, it is more economical to apply a moderate rate over the whole maize farm than to apply a high rate on part of the farm. If the rate is too low (e.g., less than 100 kg per hectare) the response will often be too small to be economical, unless the fertilizer is applied in the same hole as the seed.

TIMING: The 20-10-10 should be applied twice to compensate for loss of Nitrogen by leaching. Half of the fertilizer should be applied at planting or just after germination. The second half is to be applied at about six (6) weeks after planting, or when the maize is about knee high.

M E T H O D: There are three ways to apply fertilizer to maize :-

- Broadcast application,
- Banded application, and
- Ring application.

When using moderate levels of fertilizer, it is usually wasteful to use the broadcast method, which involves spreading the fertilizer over the entire surface of the soil and mixing it with the soil. Much of the Nitrogen, in particular, will be leached from the soil between the rows before the maize roots have grown enough to reach and absorb it.

The ring method of application is used after the maize plant has emerged from the soil.

.../.

The fertilizer is applied in a ring around the base of each plant about 5 - 8 cm from the plant. It is very effective in assuring the efficient use of the fertilizer, but is extremely tedious (labor intensive).

The Banded Application Method has the advantage of using the fertilizer in an efficient manner, while requiring less labor than the ring application method. At planting, a 3 - 4 cm deep trench can be opened with a hoe or stick just beside or below the row to be planted with maize, and the fertilizer spread evenly along the bottom of the trench. The fertilizer should then be covered with soil, and care taken that the fertilizer doesn't come in contact with the maize seed. At six (6) weeks, the second application should be banded in the same way, but to one side of the maize row, taking care not to place the fertilizer so close to the plants that they are burned by the fertilizer.

In short, to be reasonably sure of good results; use a moderate rate of 20-10-10 fertilizer (250 - 300 kg per hectare), applying half at planting and half six weeks later, and use the banded method of application.

7. W E E D I N G:

7.1 ADVANTAGES OF WEEDING.

On newly cleared land, especially bush or forest land, weeds are not likely to be a serious problem for 1 or 2 years. But thereafter, weeds become a bigger and bigger problem. Some weeds, in particular, are troublesome for maize farmers, e.g., *Imperata cylindrica* (spear grass).

Weeds have a number of bad effects on a growing maize crop, each of which underscores the advantages of weeding the farm.

- Weeds compete with the maize for soil nutrients, water and light.
- Weeds harbor insect pests that can attack the maize.
- Weeds serve as alternate hosts for disease organisms that attack maize.

.../.

7.2 METHODS OF WEED CONTROL:

Several methods of weed control exist, including chemical control with herbicides (effective and time saving, but costly while posing a risk to the farmer by virtue of their high toxicity), mechanized cultivation using a tractor and manual weeding by hand or with a hoe (very effective, but extremely tedious and time consuming).

Manual weeding has the added advantage of being more effective in mixed cropping systems, where a herbicide or mechanical cultivator might damage the associated crop(s).

The critical period for weeding maize is during the first 40 days after planting. One should keep the following points in mind.

- Plant the maize early, soon after the start of the rainy season, to get a jump on the weeds.
- Weed at least twice during the season:
  - the first weeding at about 3 - 4 weeks,
  - the second weeding at 6 - 8 weeks after planting.
- Only shallow weeding is recommended for maize so as not to damage the roots.

8. DISEASE AND PEST CONTROL:

8.1 THE CORN STALK BORER:

The corn Stalk Borer is a common Pest in maize, especially with second or late season maize. The larva (a pinkish worm) burrows into the stem and ear. If the attack occurs at an early maize growth stage, the plant will die yielding no ear. If late, the Borer will cause damage to the ear, and Promote ear rots.

Control of Stalk Borers can be effected in a number of ways.

- Plant resistant varieties of maize.
- Affected plants should be uprooted and burned or buried deep beneath the soil.
- Use insecticide sprays or powders at the first indication of infestation.

.../.

8.2 MAIZE DISEASES.

A wide variety of diseases occur in maize, and in some cases can seriously affect yields and quality of the maize. The most common diseases of maize found in Cameroon include Maize Leaf Blight (both highland and lowland versions), Maize Rust (also with highland and lowland varieties), Maize Streak Virus (MSV) and Maize Smut. Other maize diseases exist, but are less prevalent, and therefore of less economic importance.

In most cases, the disease can be recognized by characteristic lesions (spots) on the leaves of the maize. For example, Maize Rust is characterized by small reddish spots, Highland Leaf Blight by long spindle-shaped, greyish lesions and streak Virus by parallel narrow white stripes, often running the length of the leaf.

Maize diseases are most effectively controlled by:

- Using resistant maize varieties (the best method),
- Removing and burning or deep-burying affected plants,
- Using a crop rotation.

9. H A R V E S T:

9.1 DATE OF HARVEST.

About 5 - 8 weeks after flowering (i.e., appearance of silks), the maize is ready for harvest, as a dry grain. The precise date of harvest will depend on a number of factors, including:

- Date of planting,
- Altitude of the farm, and
- Variety of maize (short or long cycle).

Ideally, maize should be harvested when the grain moisture content is below 20%. However, this is often impracticable in the Western highlands of Cameroon, where first season maize is harvested at the peak of the rainy season. Typically, the maize harvested in July to September will have a grain moisture content somewhere between 25 and 40%. The maize must then be dried to below 15% for effective storage.

.../.

9.2. HARVEST METHODS.

Maize can be harvested either as green ears or dry grain, depending on the final use. It can also be picked with or without the husk (sheath). The method adopted will influence the choice of drying and storage method.

10. STORAGE OF MAIZE:

10.1 STORAGE METHODS:

Maize for dry grain can be stored on the farm in any of the following ways:

1) In the ceiling of the kitchen with the husk on,
2) In a corn crib;
3) Dehusked and hung from bamboo rails under the eaves of the house; or,
4) Shelled in jute bags, clay pots, wooden buckets or large baskets.

The first three methods can be used with maize directly from the farm, because they provide for drying the maize. The maize, however, must be dried before storing the shelled grains.

Although commonly done in many areas, there are certain disadvantages to storing maize with the husk.

1) It is difficult to eliminate ears that are diseased.
2) Unseen weevils can be carried, hidden in the husks, into the place of storage.
3) The extra water contained in the husk makes drying of maize slower and more expensive if wood is being burned to dry it.

An effective way of drying maize is with a "SAMOAN" - Type Drier. It is simple to build and can serve as a storage house after drying.

10.2 CHEMICALS USED FOR STORING MAIZE:

Once the maize is sufficiently dry (< 15%), it can be shelled and stored in jute bags or other containers. If stored for an extended period, an insecticide should be used to prevent weevil damage.

.../.

The chemical used depends on whether the maize is being stored for seed or for food.

SEED MAIZE STORAGE:

CHEMICAL	QUANTITY PER 100 KG GRAIN	COST
Linda Granox	200 grams	570 CFA/KG
Zithiol	300 grams	280 CFA/KG
Servin 85 dust	14.2 grams in 4.5 liters water for 1 ton grain in bags	500 CFA/KG

FOOD MAIZE STORAGE:

CHEMICAL	QUANTITY PER 100 KG GRAIN	COST
Actelic 2%	20 g/liter of water sprayed on the external surface of the bag.	600 CFA/K
Actelic Liquid (powder)	250 g/liter and spray as above	" "
Malathion	60 grams of 1.0% dust	" "
Lindane	60 grams of 1.0% dust	" "

With chemicals, maize can be stored for upwards of 7 months with greatly reduced loss from weevils. Without chemicals, over half the maize can be lost within 6 months.

IMPORTANT NOTE: NEVER STORE TREATED SEED MAIZE WITH FOOD MAIZE !!!

11. COSTS AND RETURNS FOR GROWING MAIZE.

The costs and returns to maize production vary with the nature of the enterprise (manual vs mechanized), the size of the farm, the factor inputs used (e.g., fertilizer), the market outlet and the proximity of the farm to that market.

Most maize production in Cameroon is by purely manual means, on farms of less than 3 hectares. Therefore; the following cost budget, which assumes non-mechanized production using an improved maize variety and 250 kg of 20-10-10 fertilizer per hectare, is proposed as a rough approximation of the costs (cash and opportunity) of growing one hectare of maize.

---

[1] Instructions on how to build a Samoan-type dry-house can be obtained by contacting IRA-BAMBUI, P.O. Box 80 BAMENDA, N. W. PROVINCE.

OPERATION/FACTOR INPUT	QUANTITY (labor/factor)	UNIT COST (CFA)	TOTAL COST (CFA)
Land Clearing[2]	40 mandays	600 CFA/md	24.000 CFA
Tilling	80 "	"	48,000 "
Ridging'	20 "	"	12,000 "
Maize Seed	25 kg	200 CFA/KG	5,000 "
Fertilizer (20-10-10)	250 kg	40 CFA/KG	10,000 "
Fert. Applications (2)	8 mandays	600 CFA/md	4,800 "
Weeding (2)times)	30 "	"	18,000 "
Harvesting	20 "	"	12,000 "
Wood for Drying[3]	25 cu. m.	800 CFA/m3	20,000 "
Labor for drying, shelling and bagging	6 mandays	600 CFA/md	3,600 "
Chemicals for Storage (Actelic 2%).	7 kg	600 CFA/kg	4,200 "
		GRAND TOTAL =	161,600 CFA

Assuming a maize yield of 3.5 tonnes, the breakeven price of maize would be 46 CFA/kg, or 690 CFA per 15 litre bucket of maize. Immediate post-harvest maize prices in the North-West and West Provinces for 1984 varied between 37 and 50 CFA per kg.

If the farmer decided to economize by using his own local maize variety with no fertilizer, his total production costs could be reduced to 142,800 CFA. However, a yield study conducted by MIDENO in 1983 showed that average maize yields in the North-West Province, where the vast majority of farmers grow a local variety without fertilizer, were in the neighborhood of 1.8 tonnes per hectare. At that yield level the breakeven price of maize is 79 CFA/kg. It pays to use the improved variety with fertilizer even if yields are increased by as little as 500 kg/Hectare, bringing the breakeven price down to 70 CFA/KG of maize.

---

[2]As a guide, one (1) tractor hour is assumed to be equivalent to ten (10) mandays (md). One (1) manday is taken to be seven (7) hours.

[3]Assumes a yield of 3,500 kg of maize per hectare.

ENNN/Nju::

REPUBLIQUE DU CAMEROUN
PAIX-TRAVAIL-PATRIE

MINISTERE DE L'ENSEIGNEMENT SUPERIEUR
ET DE LA RECHERCHE SCIENTIFIQUE

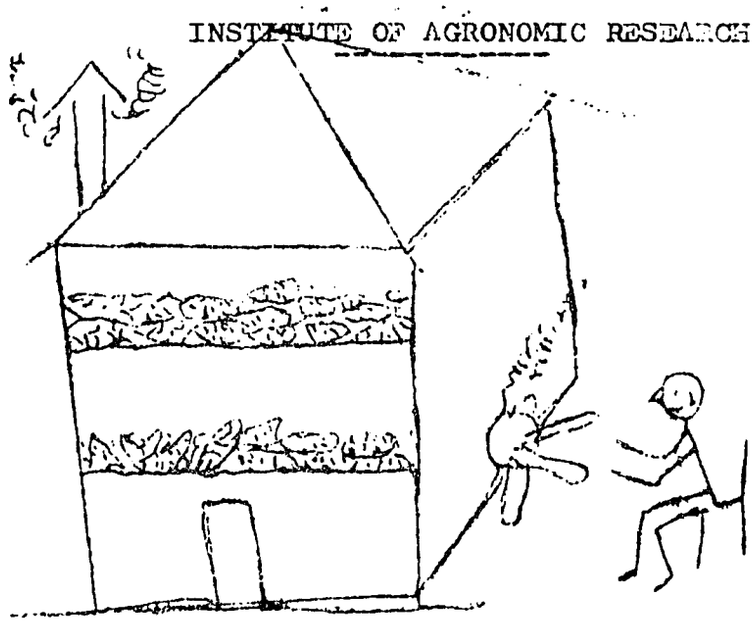
REPUBLIC OF CAMEROON
PEACE-WORK-FATHERLAND

MINISTRY OF HIGHER EDUCATION
AND SCIENTIFIC RESEARCH

INSTITUT DE LA RECHERCHE AGRONOMIQUE

I. R. A.

INSTITUTE OF AGRONOMIC RESEARCH



TECHNICAL BULLETIN No 4/80/IRA/BAMBUI

THE SIMPLE BATCH DRYER FOR MAIZE AND OTHER GRAINS

Produced by:

Edward Ngong-Nassah
Extension - Agronomist
IRA BAMBUI STATION

and

Jacob Ayuk-Takem (DR.)
Senior Maize Breeder and
Cereals Research Coordinator
IRA/MESRES, CAMEROON.

THE SIMPLE BATCH DRYER FOR MAIZE

Studies in Cameroon show that the greatest problem to maize production is that of drying and storage. Infact in a recent survey with maize farmers, this problem was marked as the first in a list of problems.

Why is the problem so felt? Because farmers adopt a wasteful way of drying and storage. For example,

- early maize is harvested in the peak of the rains with a high moisture content.
- maize is harvested with the sheath on which is wet and envelopes a lot of water;
- the maize harvested has between 30 - 35% moisture, i.e. for every 100 kg of maize cob harvested at that time 30 - 35 kg (or litres) is water. You need to drive off 16 - 19 litres of water from this maize to bring it down to storage moisture content of 14 - 15%;
- Since maize is dried with the sheath by most local farmers, the sheath and the water which it envelopes must first be dried <u>before</u> the grain is dried.

<u>Therefore</u> a lot of firewood is needed which is quite expensive. For lack of firewood, the maize is inproperly dried and can develop mould leading to great losses.

But suppose the farmer had enough wood to dry his maize in the ceiling of his living house, how long does it store up there? Farmers admit that their maize is heavily weeviled after three months from harvest.

Because of weevils, moulds, rats, it is estimated that the village farmer is loosing 25 - 35% of his stored grain to the above agents.

The Agronomic Research Station, Bambui has perfected an artificial maize/grain dryer which uses firewood and is very cheaply constructed.

It is the purpose of this bulletin to explain how the local farmer can construct and use this dryer.

...../.

HOW DOES THIS DRYER WORK?

It is basically a batch dryer and consists of a rectangular or square house. The house is built with locally sun-dried blocks and for durability, the roof is covered with corrugated iron/ aluminium sheets. Shelves are constructed inside on which the maize to be dried is laid.

A flue is made of used oil drums which forms a chamber and is fired from outside the house. Heat in the flue of drums heats the air inside the house and it is this heated air that dries the maize.

Maize to be dried can either be shelled or left on the cob before drying. If on the cob the cobs can be spread to a depth of 30 - 40cm deep. The lowest shelf must be at least 1 1/2m from the top of the flue (i.e. the drum). The heat in the drying house is maintained at 40 - 50°C. Depending on the size of the house, up to about 6000 kg of cobs can be dried down to a moisture content of 14% in 60 - 72 hours of continuous drying. Depending on the quantity of maize, - drying can be done in one or more batches.

T Y P E S:

There are two types of this dryer. For both, material needed to build the dryer are relatively cheap - sundried blocks, bush poles, bamboo, used oil drum, a few kilograms nails and a few sheets of corrugated aluminum/tine.

T Y P E I

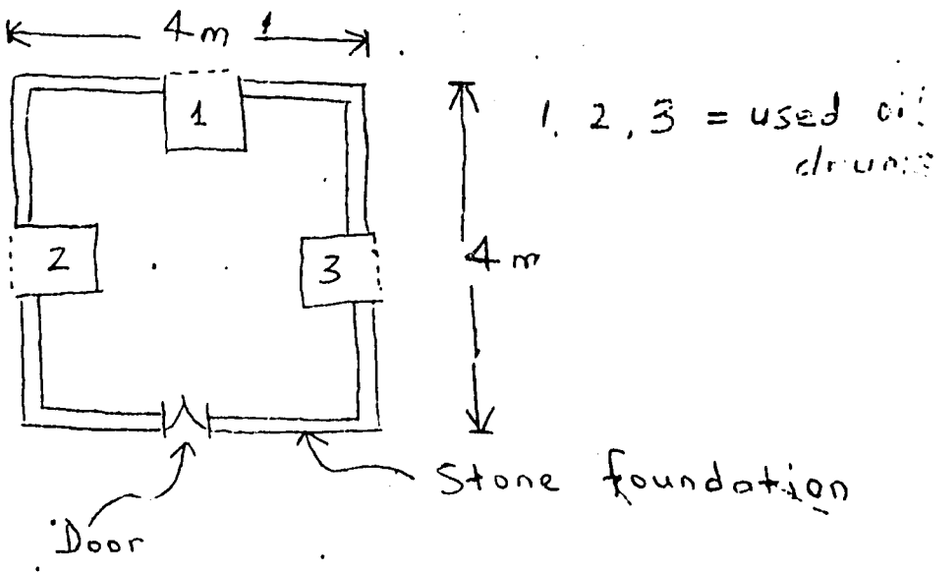
The walls of this type are about 4 metres long by about 4 metres high. On one wall is located the door. On the other three walls one oil drum each is used. It is built into the wall at ground level bisecting the length of the wall into two equal halves.

...../.

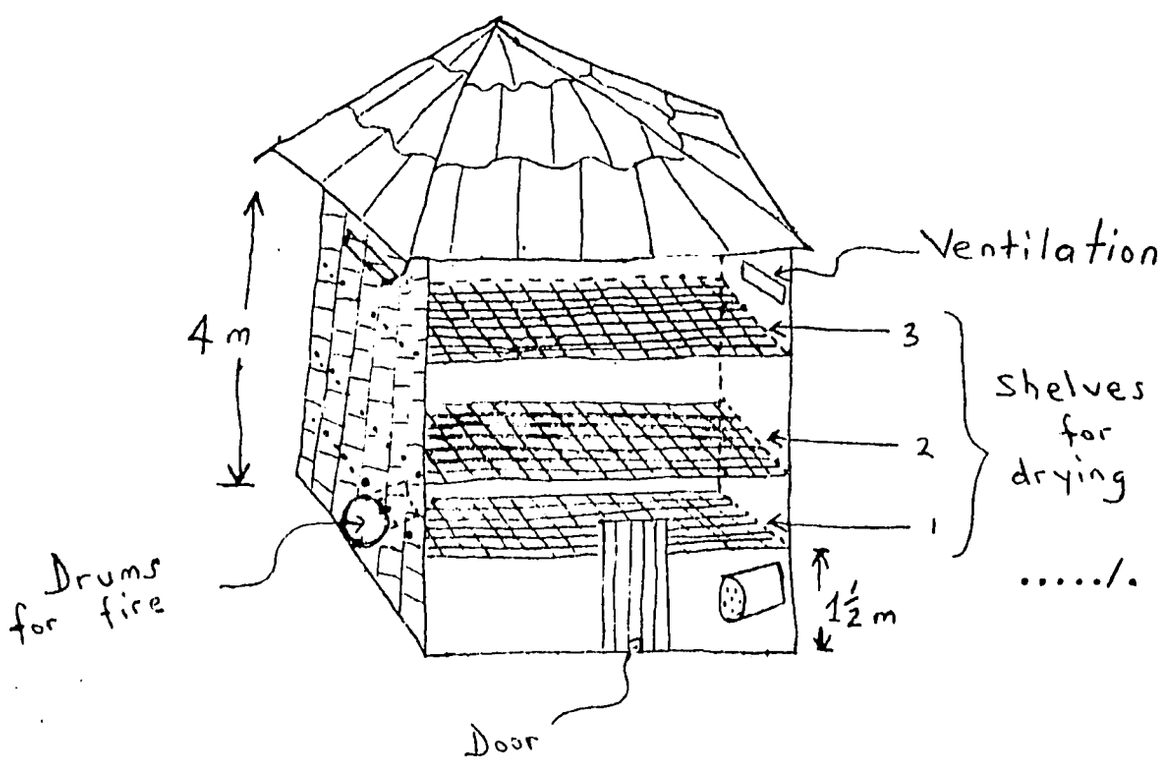
The closed end of the drum is perforated and the drum is located in such a way that the open end flushes with the outer surface of the wall.

Inside the house two or three shelves can be constructed with bush poles, bamboo and even bush rope in the same manner that a ceiling is constructed in local village houses.

I. Floor Plan



II. View of the inside of the dryer



...../.

TYPE II

This type is 2 - 3 times as large as the type I and the arrangement of the shelves and the heating drums is somewhat different.

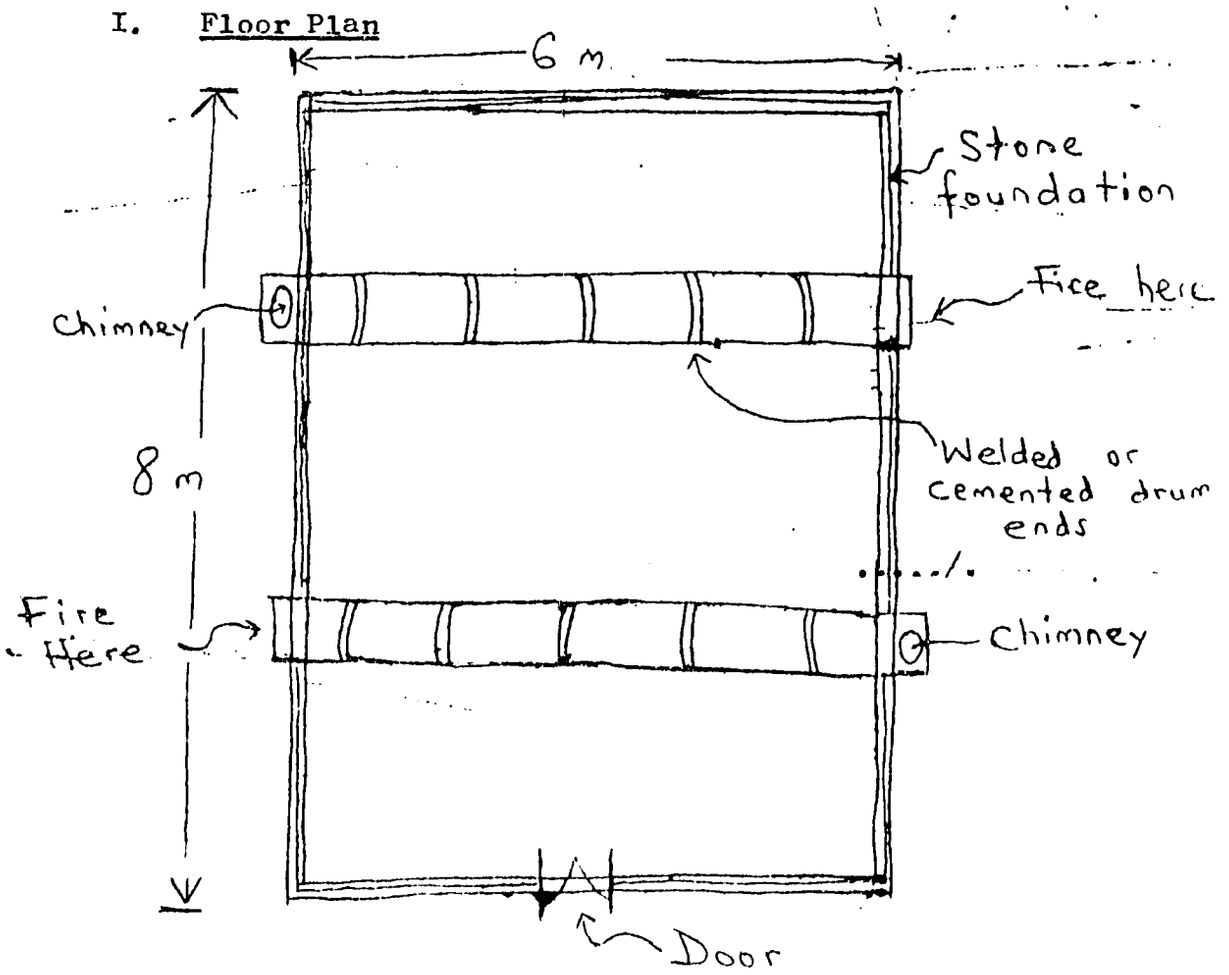
The drums are opened both ends and are placed end to end to form two flues that go accross the width of the whole drying house to the other long wall. The ends of the drums that join each other are welded or cemented to avoid smoke from rising unto the cobs/grain.

Fire is made at the alternate ends of the flues and smoke gets out through constructed chimneys at the other alternate ends.

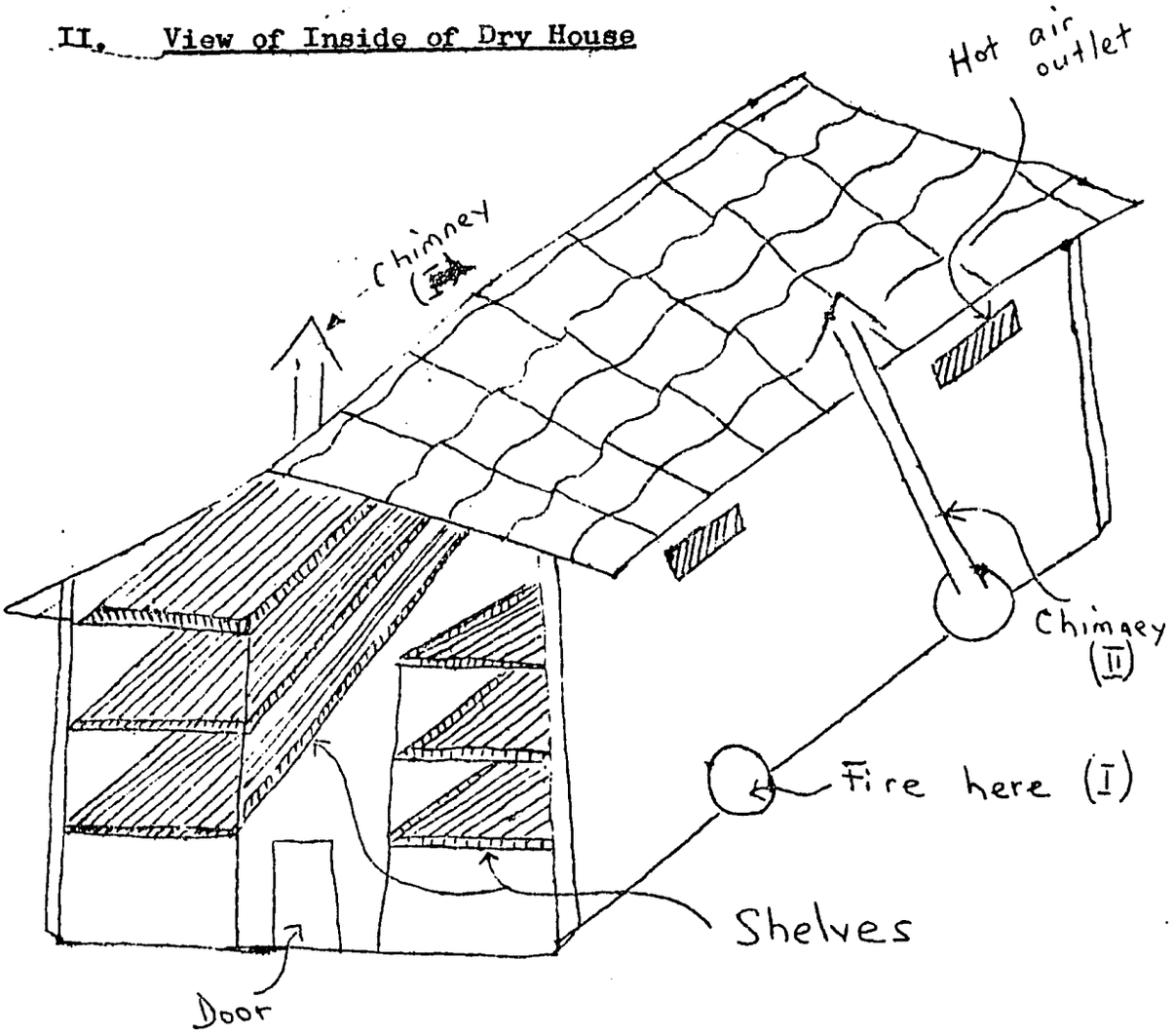
The door opens on the short end of the dry house unto a loading alley with 2 - 3 shelves on each side, constructed with local material.

Drying down to about 14% moisture is achieved in 60 - 72 hours with a temperature of 40 - 50°C.

I. Floor Plan



II. View of Inside of Dry House



FACTORS TO CONSIDER IN SELECTING A DRYER

1. Hectarage and output:

A farmer may have only 1/2 - 1 ha of maize which may yield about 500 - 1500 kg of maize cob. In this case the farmer may need the Type I dryer which can hold from one to three tons of maize cob.

If the farmer or group of farmers can jointly harvest more than three tons of maize cob the Type II dryer is recommended.

...../.

2. Crop:

This type of dryer not only dries maize, it can also dry other cereals and grain e.g. beans, rice, groundnut, etc. but the temperature and duration of drying can be adjusted accordingly.

3. Increased Yields:

The farmer or group of farmers must allow for increased harvest when constructing the dry house to avoid breaking down the walls of the house for future expansion.

4. Wood:

You must have a ready source of firewood. It is estimated that to dry 7000 kg of maize cobs you require 25 steres (cubic metres) of firewood.

5. Marketing:

The price of maize after proper drying and storage is also to be considered. Local experience shows that the price of good maize grain goes up from about 17 frs/kg at harvest season to about 70 frs/kg after storage for 4 - 5 months.

It is also known that your cost of producing 1 kg of maize is between 39 francs and 43 francs. Therefore it will be more profitable to dry your grain properly and store your maize and sell it at a later date if you must make a profit.

6. Labour:

You have to consider both skilled and unskilled labour. These are necessary both for the construction of the house and for the drying operation. You require a more even and continuous temperature at drying than a temperature which fluctuates drastically. For this you require a skilled labourer.

...../.

7. Capital:

The capital outlay must also be considered. The Type I dryer is less expensive than the Type II dryer and the size of the house should be adjusted to the needs of the farmer.

ESTIMATED COSTS OF DRYERS

For the Type I - DRYER

Diamensions 4m x 4m x 4m

Number of sundried blocks = (20cm x 30cm x 15cm)	= 1300	
@ 10 francs each	= 13.000	frs
1 trip of stones for foundation	= 7.000	"
1 bundle of zinc	= 42.000	"
3 kg of zinc nails	= 1.500	"
Local Poles for roof	= 4.000	"
Wire Nails for roof = 8 kg @ 300 frs each kg	= 2.400	"
3 used oil drums	= 9.000	"
Bush poles and bamboo for shelves	= 5.000	"
Timber for door and nails	= 3.000	"
Padlock	= 600	"
Workmanship	= 20,000	"
	102.500	frs

If you intend to dry beans or rice etc. you need an additional 27 square metres of wire-mesh.

For the Type II - DRYER

The cost of the Type II dryer is about double that of the Type I house but much depends on the diamensions chosen by the farmer.

N o t e: If the house is properly constructed and used, it can last for a period of 25 years or even more.

...../.

TREATING THE MAIZE AGAINST WEEVILS

After your maize is dry, shell it immediately and treat it against weevil attack. Then store the maize properly.

- Keep grain cool and dry, protected against insects and rodents.
- Use insecticides on all sacks and other storage containers. Meet your extension worker for directions.
- After your grain has been shelled and treated clean the dry house properly, dust it with an insecticide and you may use it to store the grain in sacks or other containers.

Remember! Grain which is properly dried, properly treated with insecticide and properly stored in a clean, cool, dry place can store for more than 6 months without losses to insects, moulds and rodents.

0o0o0o0o0o0o0o0o0

ENNN/Nju::

REPUBLIQUE DU CAMEROUN
Paix - Travail - Patrie

MINISTERE DE L'ENSEIGNEMENT SUPERIEUR
ET DE LA RECHERCHE SCIENTIFIQUE

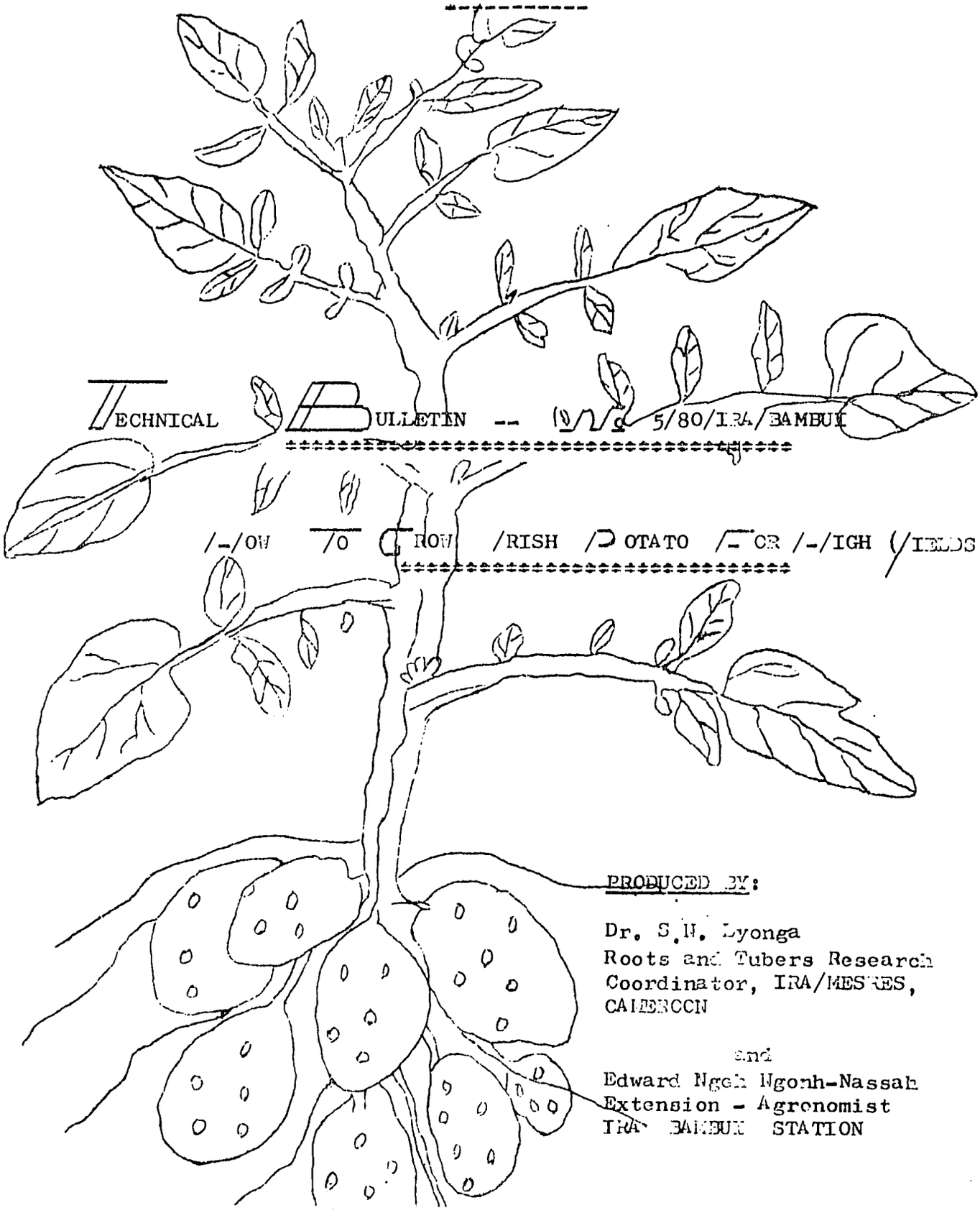
REPUBLIC OF CAMEROON
Peace-Work-Fatherland

MINISTRY OF HIGHER EDUCATION
AND SCIENTIFIC RESEARCH

INSTITUT DE LA RECHERCHE AGRONOMIQUE

I. R. A.

INSTITUTE OF AGRONOMIC RESEARCH



TECHNICAL BULLETIN -- No 5/80/IRA/BAMBUI

LOW COST IRISH POTATO FOR HIGH YIELDS

PRODUCED BY:

Dr. S.N. Lyonga
Roots and Tubers Research
Coordinator, IRA/MESTES,
CAMEROON

and

Edward Ngeh Ngonh-Nassah
Extension - Agronomist
IRA BAMBUI STATION

IRISH POTATO PRODUCTION

INTRODUCTION

In the cooler highland areas of Cameroon, Irish Potatoes have been an important food crop. The crop itself is not native to Cameroon. It's original home is South America around Peru and Bolivia. It was introduced to Cameroon by the European Explorers early this century.

Although potato is a temperate zone crop it has been found to do well in the highland plateaux of Cameroon (1000 - 2000 metres above sea level) notably in the North-West and Western Provinces, giving quite encouraging yields.

Once regarded as the "white man's chop" Irish Potato has recently assumed a great importance to the Cameroonian farmer and consumer both as a food and cash-crop. There is a high potential of the crop fetching foreign exchange from neighbouring countries.

USES OF POTATO

Potato has several uses besides being a good supplier of energy to the consumer - which is its main use. It is eaten boiled, roasted, baked or fried. It can also be processed into canned whole potatoes, frozen french fries or chips, dehydrated flakes, powder or granules, potato salad etc.

Other uses into which potato can be put are:

a) Livestock (animal) feed
b) Starch manufacture
c) Flour making
d) Alcohol production
e) Production of high-grade protein from potato fries
f) The leaves are used as vegetables in certain parts of the world.

Currently in Cameroon there is a high demand for potatoes throughout the year.

The Institutes for Agronomic Research Dschang and Bambui Stations have conducted research work on potatoes for several years, and it is the purpose of this bulletin to briefly present how Irish Potato can be grown for high yields in Cameroon.

IN WHAT CLIMATE DOES POTATO DO WELL?

The available varieties of potato in Cameroon requires a cool growing season with a temperature range of 15 - 18°C.

Cameroonian varieties of potatoes do not do well in areas of very heavy rains. A rainfall of 500 - 750mm evenly distributed throughout the growing period is considered essential.

When grown under humid conditions the incidence of blight is often high and control difficult.

WHAT SOILS ARE GOOD FOR POTATO?

Optimum yields are obtained in:

- a deep well-drained loam or sandy loam soils that are light and well aerated.
- soils that are free from stones.
- soils that are slightly acidic - 5.5 - 6.0 pH.
- soils that are rich in organic matter are particularly recommended.

HOW DO YOU PREPARE YOUR LAND FOR POTATO?

1. Clear your land well.
2. Remove (coarse) material for burning (outside the field in a heap) spread the wood ash evenly over the plot if necessary).
3. With soft trash prepare compost.
4. Use the compost in the field while making ridges.

You obtain good yields of potatoes when grown on ridges with a fine tilth which are at least 25 - 30cm deep, and 80cm from top to top.

...../.

WHAT SEED SHOULD YOU PLANT?

Tubers, either whole or cut, known as potato "seed" are used. Whole tubers are preferred because cut tubers may rot in the ground. The tuber should weigh 45 - 55 grams.
Rub cut surfaces with woodash.

The tuber should be:

- good and healthy i.e. free from diseases and pests.
- adapted to the region.
- free from mechanical damage
- must have been stored and prepared for planting correctly.

Whenever possible "seed" (tubers) from the research station is preferrable.

HOW DO YOU PREPARE YOUR POTATO SEED?

Freshly harvested potato is not good for seed. It must rest before it is ready to sprout. Seed potato must be obtained from fully mature plants.

After harvesting your potato select tubers that weigh approximately 45 - 55 grams, and which are free from mechanical damage, wounds or bruises.

. Select seeds that are free from diseases and pests.

. Keep these seed in a cool, airy, dry place for about 8 weeks.

. When they begin to sprout from the "eyes" then you have good seed for planting.

. Do a final selection - removing rotted and diseased tubers.

WHEN DO YOU PLANT YOUR POTATO?

In the potato growing areas of Cameroon the crop is grown twice a year with plantings in February and August. Three crops may be grown if irrigation is available. For the early crop it is preferable to have the seed in the ground before the onset of the rainy season i.e. by end of February. This way your crop escapes the attack of late blight, because growth is faster and it matures before real heavy rains in July.

/

The late crop planted mid - August to end of August has at least 2 months of rainfall before the onset of the dry-season & time when late blight is reduced because of reduced humidity.

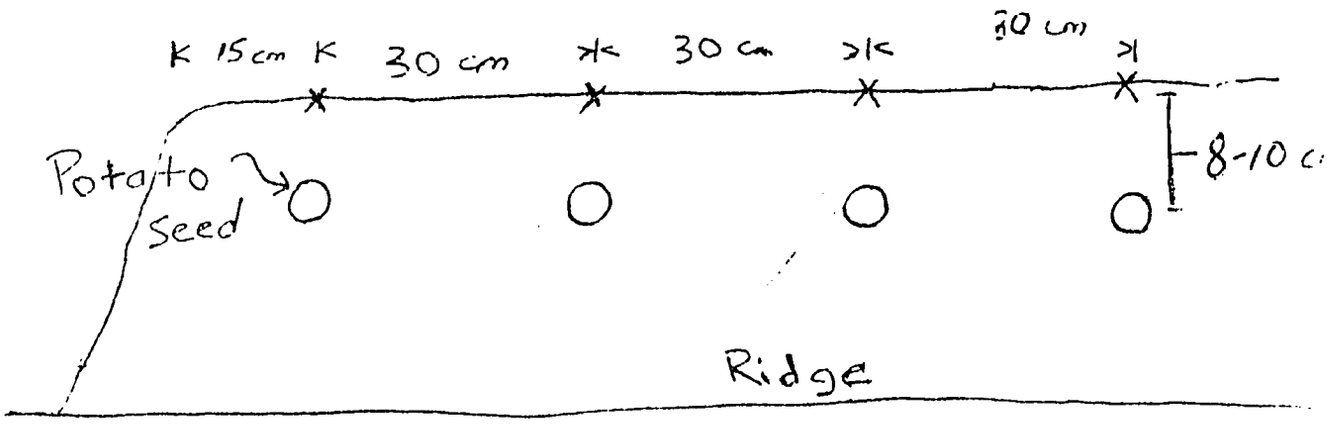
HOW DO YOU PLANT YOUR POTATO?

In Cameroon potato is still planted by hand, on ridges

- at a depth of 8 - 10cm
- at a spacing of 30cm
- on ridges 80cm from top to top.

SEED RATE: This depend on the spacing and whether the potato is planted sole or in association with other crops. If planted sole and as whole tubers, you require 1500 - 1800 kg/ha.

S K E T C H:



CAN YOU INTERCROP YOUR POTATO?

It is difficult in Cameroon to find a sole crop of potato on the farmers farms.

Research work is continuing in order to find out which is the best combination to make. For now it is recommended that for best yields potato should be planted as a sole crop. Potato does best when exposed fully to sunlight.

...../.

FERTILISER AND ORGANIC MATTER USE ON POTATO

Potato does well on well-rotted Farm Yard Manure, or (Compost). Fertilizers are expensive to buy but a wise use of them can increase your potato crop yield. Since soils, and rainfall patterns differ from place to place, it is not possible to recommend a strict dose of fertilizer for the potato crop. However, research in the two Agronomic Stations of Bambui and Dschang recommends:

1. If your soil is very fertile, and rich in organic matter there should be no need for chemical fertilizers.
2. One dose of N P K (20: 10: 10 or 15: 15: 15) at the rate of 10 grams per plant in moderately fertile soils plus 10 - 25 ton of Farm Yard Manure.
3. Two split applications of N P K as follows:

   N = 80 units/ha = 354 kg of Sulphate of Ammonia
   P = 100 units/ha = 550 kg of Single Superphosphate
   K = 30 units/ha = 51 kg of Potassium Chloride
   955 kg of N.P.K

WHEN DO YOU APPLY FERTILISER

- The manure 10 - 25 tons and then all the P and K should be applied at land preparation, that is mixed with the bed.

  N - should be applied about 2 weeks after sprouting i.e. when plants are 30cm high. Mould up the bed after application.

HOW DO YOU APPLY FERTILISER ON POTATO?

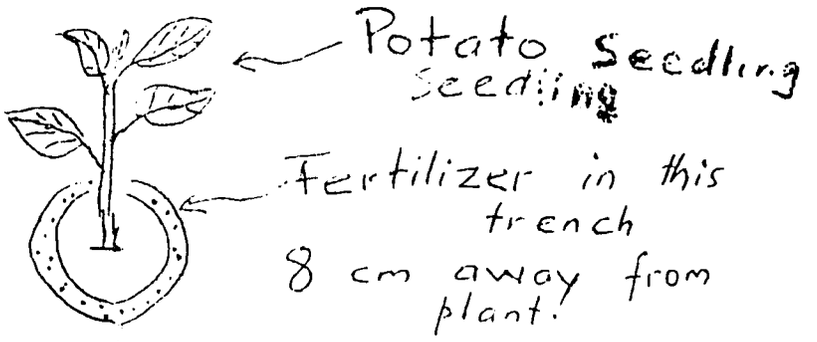
Ring Application:

If potato is grown as a garden crop you may apply the fertilizer in a ring. (Remember that one beer - cap full = 5 grams).

...../.

Apply the fertilizer in a small trenched ring 2cm deep and about 8cm away from the plant. Cover up the trench after application. Avoid the fertilizer spreading onto the stem. It may burn the stem or leaves later.

S K E T C H

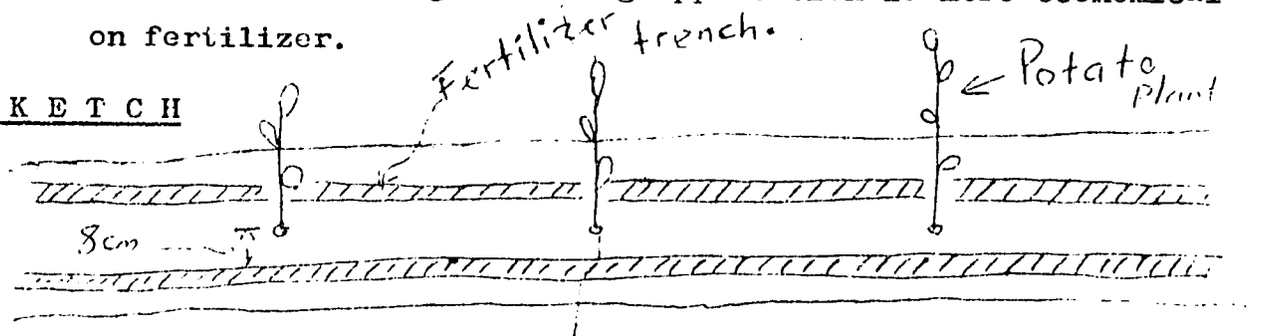


For large farms you can also apply the fertilizer in a ring without trenching. But you must immediately mould up the ridge to cover the fertilizer because it can be washed away by rain.

Band Application

This involves placing the fertilizer in a band to the side of the line of the plants. It is faster than the ring application although the ring application is more economical on fertilizer.

S K E T C H



Place the fertilizer about 8cm away on both sides of the line of plants in a band. After this, mould up the ridge in order to cover the fertilizer.

This is more practical because

- it saves time
- moulding covers up weeds
- moulding covers up the developing tubers.

* Remember that each plant takes 5 - 10 grams of fertilizer.

...../.

W E E D I N G

Weed your potato farm at least two times in the growing season. The first weeding should be done about 2 weeks after the potato has sprouted i.e. when plants are 30cm high (just before fertiliser application).

The second weeding should be done 5 - 6 weeks later.

At each weeding, mould up the ridges so that the roots of your potato plant and the developing tubers are not exposed. Take care not to wound the tubers during weeding the second time.

Weeds are bad:

- They steal plant food and water from the soil and starve your potato thereby reducing their yield.
- They harbour pests and cause diseases on your farm.
- They make harvesting of your potato difficult.

DISEASES AND PESTS

Potatoes can be attacked by many diseases and pests. The very common ones are:

P E S T S:

1. Aphids - very tiny small insects which are capable of spreading virus diseases such as leaf roll, and mosaic.
2. The Black Cutworm - it causes serious loss of the young plants by cutting the sprouted and emerging shoot of the plant.
3. Other Pests - other common pests found on potato are the potato tuber moth, root eating ants, flea beetles.

...../.

CONTROL: These insects can be effectively controlled with an appropriate insecticide spray on the leaves and at the bases of the potato stem.

The following insecticides have proved effective at this Station:

1. Nafthilo
2. Aldrin (Aldrex 40)

METHOD OF USE:

- Mix 7 grams (1 small match box full) of the powder in 4 1/2 litres of water (1 gallon) and spray onto the stem and leaves and at the bases of the plants.
- You can also mix this insecticide spray with the fungicide spray (against blight) and spray the mixture at the same time.
- To effectively control both the insects and blight, spray at a weekly interval.

DI S E A S E S:

1. Blight - One of the most widespread and serious potato disease is the potato blight. All parts of the potato are affected by the disease - the leaves turn spotted brown then black and fall-off.
   - the stems die and rot away.
   - the tubers develop dry or wet rots.

CONTROL: - Use tolerant cultivars.
- Spray once or twice a week with an appropriate fungicidde.
"Manesan", Maneb, Cuproxide, at the rate of 2 kg to 100 l/water/has been found helpful.

...../.

2. Potato Bacterial Wilt

This is also called brown rot. An attack makes the plant to wilt. Affected tubers become rotten with a very offensive smell.

CONTROL: - Use resistance varieties.
- Practice crop rotation.
- Uproot diseased plants and bury deep.

3. S c a b The tubers of the potato develop raised corky areas which are greyish white to brown in colour. The disease is common in basic soils i.e. pH above 7.

CONTROL: Use tolerant varieties.
Avoid growing potato on basic soils.

Other disorders of potato tubers are:

4. Greening - due to exposure to sunlight during the growing season. Green tubers are not good for table.

5. Hollow Heart - this is very common with large tubers. When split open there is an open cavity inside the tuber. It is not very serious.

6. Black Heart
7. Mohogany Browning
) - caused by high temperatures accompanied by poor aeration at storage. They can also be caused by high soil temperatures.

CROP ROTATION

It is not adviseable to grow potato twice consecutively on the same plot, in order to avoid heavy disease build up particularly bacterial wilts, blights, and insect attack. Fallow your land for at least one year before growing another crop of potato on it.

...../.

464

HARVESTING

Potato should not be harvested until they are fully mature, when the skins have set and are less likely to be damaged during harvesting.

- Some varieties are very early maturing taking about 70 days. Others take 95 days, some take up to 120 days.
- Potato shows signs of maturity when the leaves and vines turn uniformly yellow and die out.
- The crop can be harvested in small areas as the need arises but all of the farm must be harvested by the end of the 4th week after maturity. After this period, the tubers may start to germinate and lower your potato quality.
- When harvested, the tubers are left on the surface of the soil for about 30 - 60 minutes depending on the temperature so that the skin can dry and toughen.
- Avoid using sharp implements for harvesting. They cause bruises and wounds on the tubers and reduce their storage ability.

STORAGE

Potatoes can be stored from 5 - 8 months if the following conditions are observed.

- They must have been fully mature before they were harvested.
- The skin must be allowed to dry out preferrably in the sun for a day or so. Spread thinly in a dry place.
- Possibly spray the store with a fungicide e.g. manesan, maneb, cuproxide at the same rate as in the field against moulds and storage fungus.
- The store must be cool, dry and airy.
- The potato may be
  - spread out thinly on the storage floor (which must be dry)
  - spread on shelves in the storage house
  - packed in slatted trays 15cm high, arranged one on top of the other in the store on wooden dunages.

...../.

- You should occasionally inspect your potatoes in storage to remove rotten or damaged tubers.

* Never store your potatoes in bags or sealed containers.

Y I E L D S: Results on potato research in Cameroon give yields of between 10 tons and 25 tons for recommended varieties, depending on the altitudes which range from 1300m - 2000m above sea level.

ESTIMATED COST OF GROWING A SOLE CROP OF POTATO ON ONE HECTARE OF LAND:

LABOUR COSTS

OPERATION	HOURS MECHANISED	UNIT COST FRANCS	TOTAL COST	HOURS MANUAL	RATE /MH	TOTAL COST
Clear land	4 hrs	3.500	14.000	300	50	15.000
Ploughing	4 "	3.500	14.000	500	50	25.000
Harrowing (2x)	4 "	4.500	18.000	400	50	20.000
Ridging	2 "	4.500	9.000	300	50	15.000
			51.000			
Planting	-	-	-	70 mh	50	3.500
First Weeding and Fertilizer Application	-	-	-	35 mh	50	1.750
2nd Weeding/Mould up	-	-	-	100 mh	50	5.000
Spraying against diseases and pests	-	-	-	7 mh	50	350
Harvesting, bagging and storage	-	-	-	180 mh	50	9.000
	14	-		1.822	-	126.100

MATERIALS COSTS

	QUANTITY	UNIT COST	TOTAL COST
Seed	1.800 kg	60	108.000
Farm Yard Manure	15.000 kg	5	75.000
Fertilizer	954.000 kg	60	57.240
Chemicals	10 kg	75	750
	-	-	240.990

(* = Calculated under Bambui Conditions)

...../.

Partially mechanised production of Potato/ha = 291.990 francs

Fully manual production of Potato/ha = 367.090 francs

G u i d e:

1 tractor hours is estimated at 10 mandays

1 manday = 7 hours

10 mandays = 70 manhours (mhr)

Break-Even Points

A. Fully manual work on crop = 367.000 francs
Estimating a yield of 10 tons/ha
Break-even point = 37 francs/kg

B. Partially mechanised crop = 292.000 francs
Estimating a yield of 10 tons/ha
Break-even point is 29 francs/kg

++++++OOOOO++++++

ENNN/Nju::
REPUBLIQUE DU CAMEROUN
PAIX - TRAVAIL - PATRIE

MINISTERE DE L'ENSEIGNEMENT SUPERIEUR
ET DE LA RECHERCHE SCIENTIFIQUE

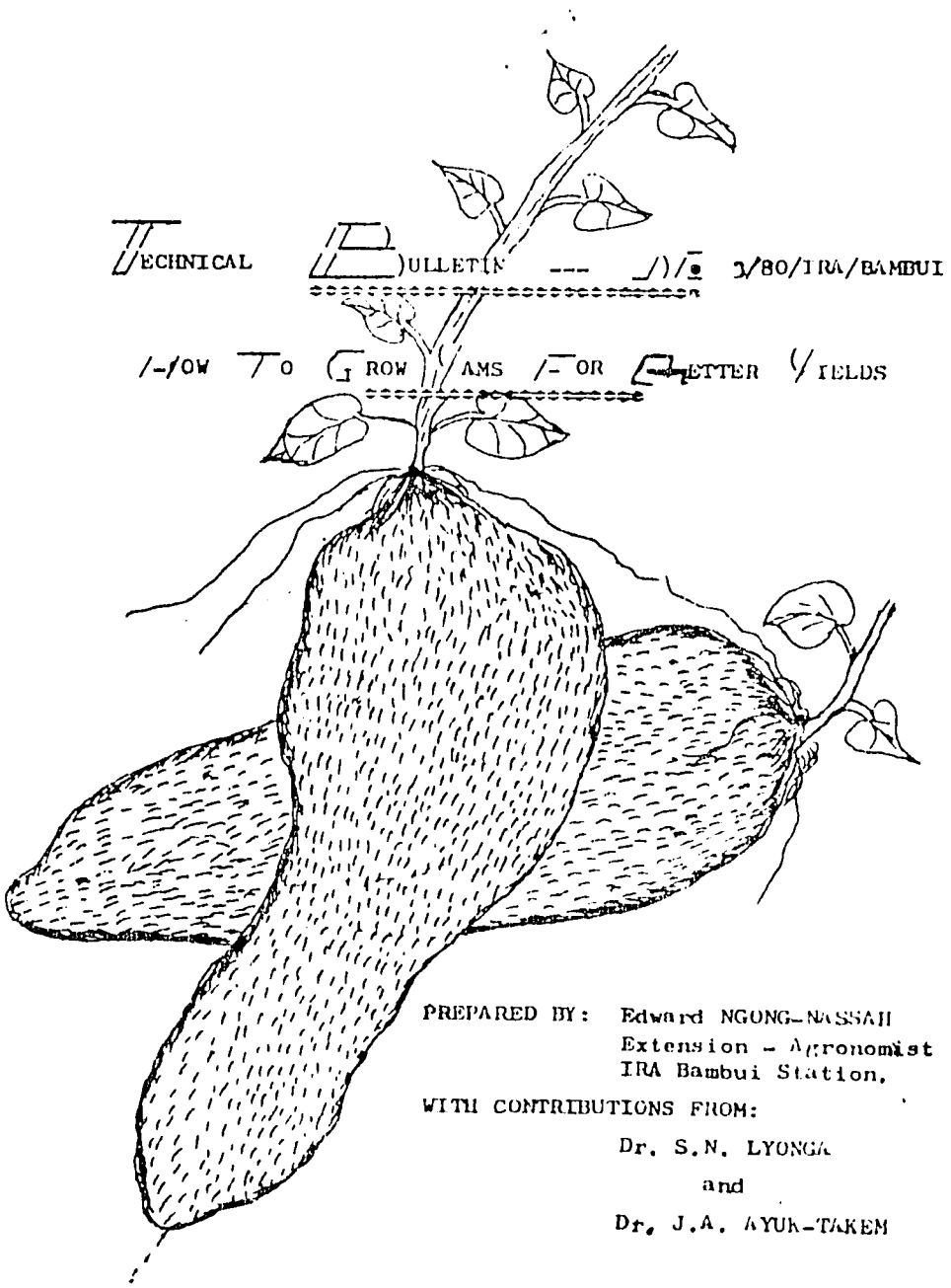
REPUBLIC OF CAMEROON
PEACE - WORK - FATHERLAND

MINISTRY OF HIGHER EDUCATION
AND SCIENTIFIC RESEARCH

INSTITUT DE LA RECHERCHE AGRONOMIQUE

I. R. A.

INSTITUTE OF AGRONOMIC RESEARCH



TECHNICAL BULLETIN --- 1/80/IRA/BAMBUI

HOW TO GROW YAMS FOR BETTER YIELDS

PREPARED BY: Edward NGONG-NASSAH
Extension - Agronomist
IRA Bambui Station.

WITH CONTRIBUTIONS FROM:

Dr. S.N. LYONGA

and

Dr. J.A. AYUK-TAKEM

C O N T E N T

	PAGE
INTRODUCTION	1
WHAT SOILS ARE GOOD FOR YOUR YAMS?	2
HOW DO YOU PREPARE YOUR LAND FOR YAMS?	2
WHAT YAMS SHOULD YOU PLANT?	3
HOW DO YOU PREPARE YOUR YAM SETTS?	3
WHEN DO YOU PLANT YOUR YAMS?	4
HOW DO YOU PLANT YOUR YAM SETT?	4
HOW FAR APART DO YOU PLANT YOUR YAMS?	5
STAKING	5
- PROCEDURE	6
- ADVANTAGES	7
CAN YOU INTERCROP YOUR YAMS	7
FERTILISERS ON YAMS	7
HOW DO YOU APPLY YOUR FERTILISERS?	8
WEEDING	8
- DISADVANTAGES OF WEEDS	9
DISEASES AND PESTS	9
HARVESTING	10
- WHEN TO HARVEST YOUR YAMS	10
- HOW TO HARVEST YOUR YAMS	11
COST OF PRODUCING ONE HECTARE OF YAMS	12

469

TECHNICAL BULLETIN - NO. 3/80/IRA/BAMBUI

Prepared by: Edward NGONG-NASSAH
Extension - Agronomist
IRA Bambui Station
P.O. Box 80 BAMENDA.

Dr. S.N. LYONGA*) (Dr. J.A. AYUK-TAKEM **
Dip. Agric; M.Sc; Ph.D.) and (Dip. Agric; D.Sc; M.Sc.; Ph.D.

-----o--o-----o---o---

HOW TO GROW YAMS FOR BETTER YIELDS

INTRODUCTION

Yam is an important food item to many Cameroonians. The Station for Agronomic Research in Bambui has improved on three highland varieties. These were selected from a collection of II4 'types' gathered from Cameroon and other parts of the world. The three main varieties recommended for the Cameroon high plateau and their average yields at this Station over a five year period are:

I. Dioscorea rotundata, commonly called the "Oshie White Yam" (ex-Oshie) yielding 25 tons/ha.

2. Dioscorea cayenensis, commonly called the "Yellow Batibo Yam" (ex - Batibo) yielding 23 tons/ha.

3. Dioscorea dumentorum, commonly called the Jakiri Sweet Yam (ex - Jakiri) yielding 45 tons/ha.

The yields were obtained with neither much application of chemical fertilizers nor any chemical disease and pest control. However, organic manures at the rate of I0 - I5 tons/hectare and good farm sanitation measures greatly increased the yields.

---

* = Agronomist
Root and Tuber Research Coordinator, CAMEROON
Chief of IRA, EKONA CHITNE, South West Province.

** = Maize Breeder, IRA Bambui and Coordinator of Cereals Programme in IRA/MESRES

WHAT SOILS ARE GOOD FOR YOUR YAMS

Yams performs best in soils that:-

- are well-drained
- aerated
- deep warm loams or silt loam
- contain abundant organic matter
- are well supplied with nutrients
- are about slightly acid to neutral, i.e. pH 5 - 7.0

Yams should not be grown on stony soils, heavily lateritic soils, stiff clayey soils, waterlogged or sandy soils. Unused soil or soil which has remained fallow is good for them.

To avoid soil erosion particularly when yam is grown as a sole crop do any of the following on steep slopes:

- contour ridging
- strip cropping
- terracing.

In the highland areas of the West and North-West Provinces of Cameroon yams are grown on high ridges usually in association with several crops, - maize, cocoyam, beans, okro, vegetables, etc. But maize inter-crop has been found to reduce yam yields.

HOW DO YOU PREPARE YOUR LAND FOR YAMS?

1. Clear your land well.

2. Remove coarse material for burning (outside the field in a heap). Spread the wood ash evenly over the plot.

3. For soft trash prepare compost.

4. Use the compost in field while making ridges.

Some farmers prefer to dig holes of from 60 - 120cm deep and about as large and fill up the holes with fertile soil before planting their yams. Some prefer to make high mounds in which they plant their yams.

...../.

Research work on yams shows that whether planted on mounds or in dug holes or on well-prepared ridges or merely well-prepared seed bed there is no significant difference in the yield. This Station recommends that yams be planted on well prepared ridges spaced at 100cm (1 metre) from top to top and about 60cm high. This is less costly than either the holes or the mounds and allows far easier inter-cropping of other crops.

WHAT YAMS SHOULD YOU PLANT?

This depends on whether you are planting yams to obtain seed-yams or ware (edible) yams. For ware yams - a sett should be 375 - 500 grammes. For seed yams 125 - 250 grammes.

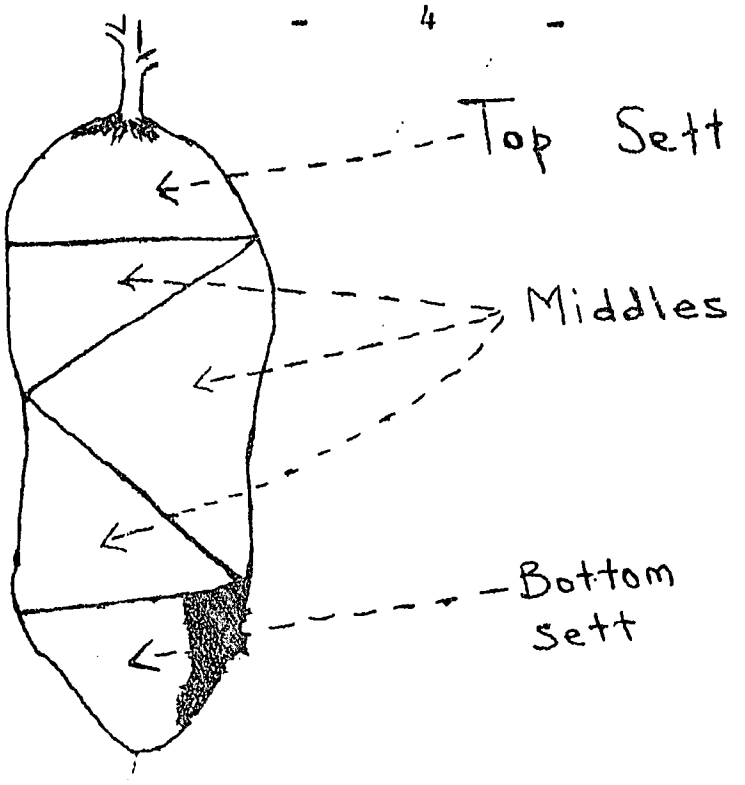
HOW DO YOU PREPARE YOUR YAM SETTS?

Usually the bigger yams are cut into the required setts. The cut surface are left to dry in a shady airy place for about 2 days. If the surfaces are not dry, the yam setts may rot in the ground. You should treat the cut surface with wood ash.

REMEMBER! For the Oshie and Batibo yams:-

- Setts from the top (the stem end) of the yam sprout better. Tops of tubers are best cut in such a way to ensure maximum of skin.
- Next are the setts from "bottom" (the end that pushes into the ground).
- The setts from the middle (have the poorest sprouting) take the longest time to sprout.

  For the Jakiri yam it is advisable that the setts have 'tops'. Sprouting more readily taken place from the tops of the tubers (i.e. the stem end).



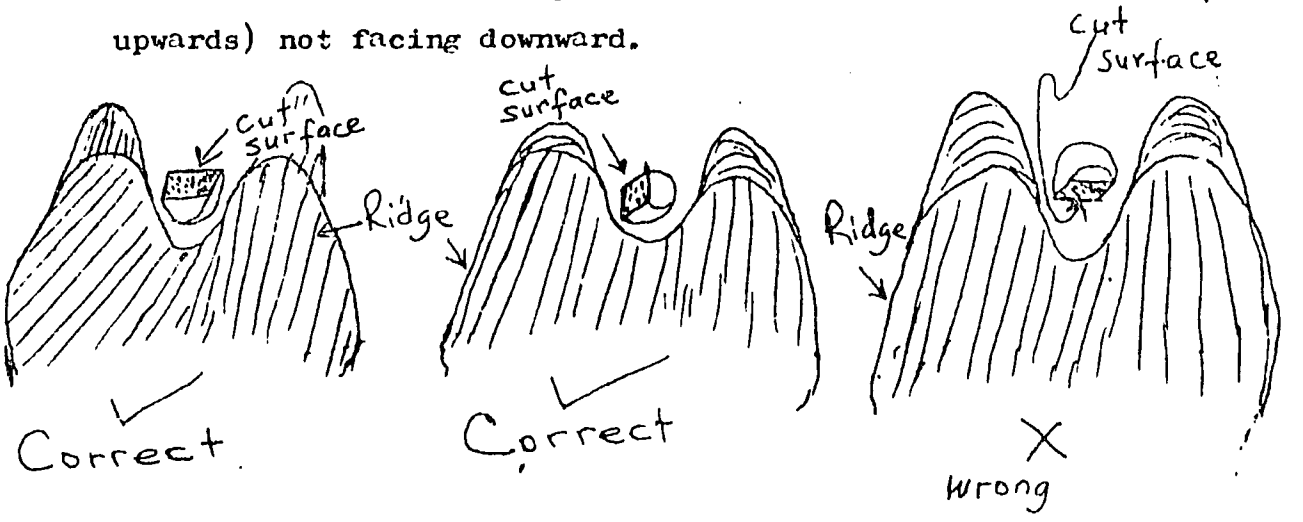
WHEN DO YOU PLANT YOUR YAMS?

In the highland areas of Cameroon, research has shown that yams planted between mid - November and mid - January gave the best yields. Therefore plant your yams between mid - November and mid - January for better yields.

After planting mulch the top with some grass or leaves and weight it down with some soil to keep the mulch in position. Mulching conserves the soil moisture around your yam sett.

HOW DO YOU PLANT YOUR YAM SETT?

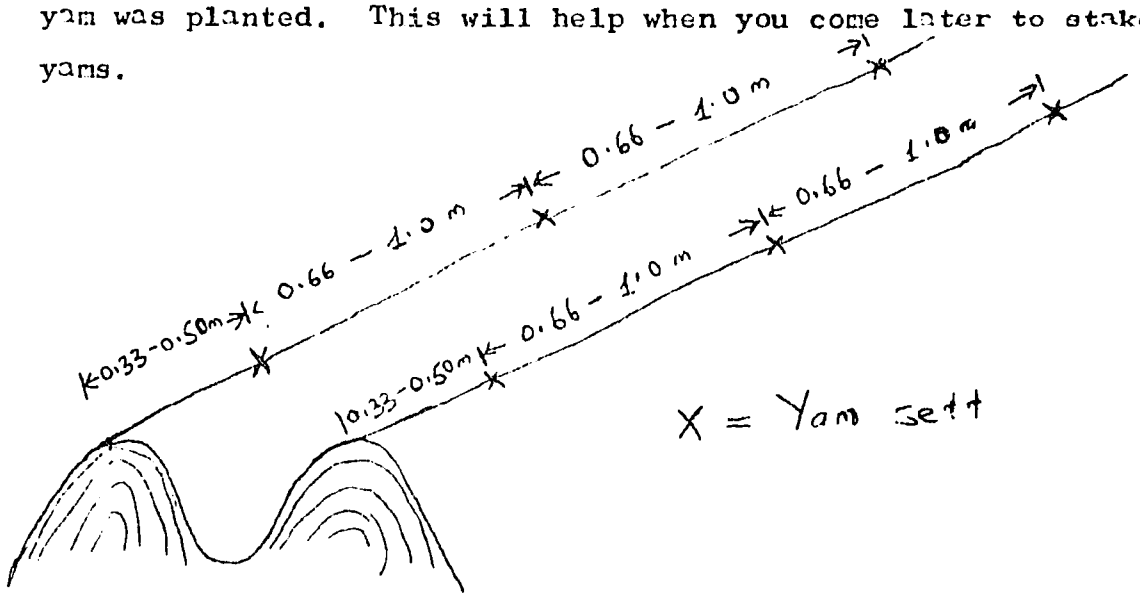
It is better to plant too deep than to plant too shallow. However, to avoid exposure to sunlight of your sett and to ensure a more even temperature around the sett, plant your yam sett at a depth of between 20 - 25cm deep with the cut surface at the side (or upwards) not facing downward.



HOW FAR APART DO YOU PLANT YOUR YAMS?

- If you intend to inter-crop plant your yams at a spacing of 1 metre along the ridge giving you a plant population of 10.000 stands/ha.
- If you are planting as a sole crop space the setts at 66cm apart, giving you a plant population of 15.000 stands per hectare.
- Always allow half of your required spacing at the end of each ridge before you plant your first yams as shown in the sketch.

Pin a short twig on the top of the planted sett to mark where the yam was planted. This will help when you come later to stake the yams.



S T A K I N G

On most peasant farms yams are either not staked or improperly staked. Research findings show that the yields of yams (Oshie white and Batibo yellow) are greatly reduced if the yams are not staked, i.e. if the vines are left to trail on the ground. Staking of yams is very important. It has been found out that it is very costly to stake yams and therefore the Station of Agronomic Research Bambui has come out with an inexpensive way of staking yams. This method of staking allows the farmer to make maximum use of the farm because many crops can be grown side by side with the yams without any of them endangering the well-being of the other if your farm is fertile. This is discussed below.

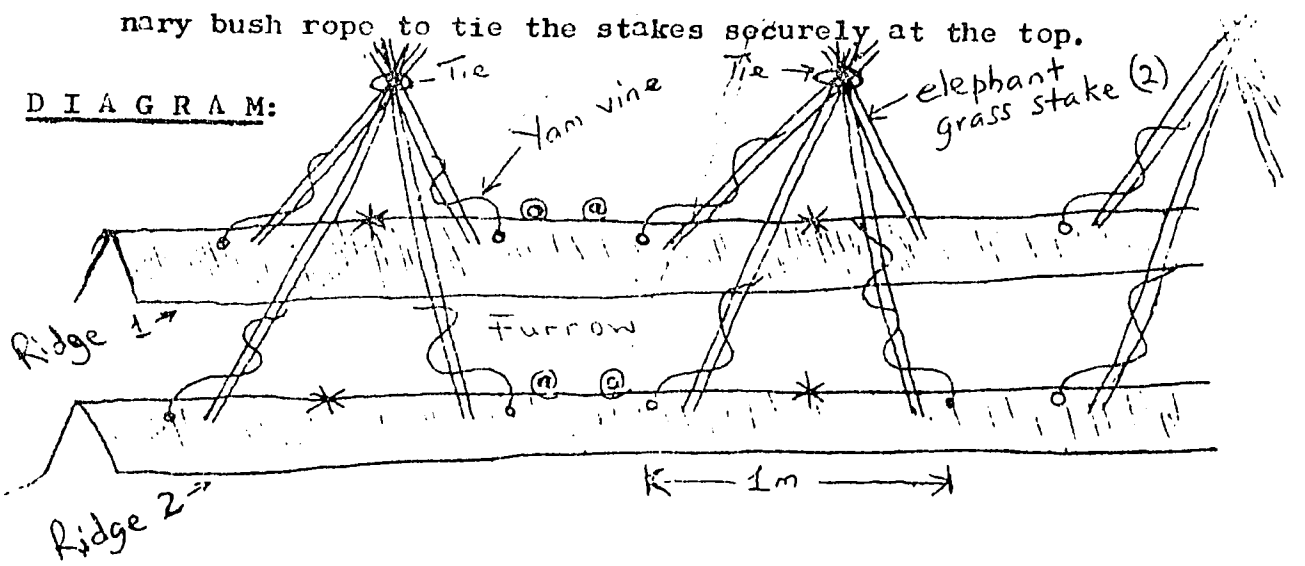
P R O C E D U R E

1. You plant your yam setts of 375 - 500 grams each at 1 metre apart on high well worked ridges 100cm from top to top. This gives a plant population of 10.000 yam stands/hectare.

2. Beginning from the end of each ridge stake 2 mature elephant grass stalks besides each yam stand. You require 20.000 elephant grass stakes for one hectare of 10.000 plants.

3. When all your farm has been staked this way go back to the beginning and tilt the stakes of 4 yams, i.e. 2 consecutive stakes on ridge one (1) and two consecutive stakes on ridge two (2) so that the tops of the 4 stakes meet above the centre of the furrow between the two ridges. Use any ordinary bush rope to tie the stakes securely at the top.

D I A G R A M:



4. Train your yams to climb clockwise for the white yams.

From this system the following crop association is possible:

1. * = cocoyam; (You can plant cocoyam between the two staked yams on each ridge under the "hut"

2. @ = legume; (You can plant two stands of dwarf beans or 2 stands of groundnuts between the two "huts"

...../.

ADVANTAGES OF THIS SYSTEM

1. Your yam yield will almost double if your yams are staked.

2. The elephant grass stalks are inexpensive to cut from the bush and almost always more available than the bush sticks which are difficult to come by particularly in the grass fields. Mature elephant grass stalks can survive one year as stakes of yams.

3. You can grow yams, cocoyams, beans, groundnuts and soybean on the same farm without endangering the well being of each crop in the association.

4. Since the crops are harvested at different times of the year, this association ensures an even distribution of labour throughout the year, and an efficient use of labour. e.g. You are weeding for yams as well as for cocoyam, beans etc.

5. Crop association are an insurrance against total crop failure i.e. if your yams don't yield well, this poor yield will be compensated for by the combined yields of the other crops.

6. Staking of your yams as described allows for more sunlight on all your crops on the farm.

CAN YOU INTERCROP YOUR YAMS?

Oh, yes! You can intercrop your yams with beans, groundnuts, etc. but your technique of staking must be proper. This technique has been explained above under "staking".

FERTILIZERS ON YAMS

Fertilizers are expensive to buy. To avoid excessive use of fertilizers on your yams, select fertile soils for your yams. Use of organic manure at the rate of 10 - 15 tons per hectare increases your yam yield.

If you must use fertilizers to increase your yield of yams - nitrogenous and potassic fertilizers are useful. Phosphatic fertilizers are not very necessary for yams.

...../.

7 - 8 bags of Sulphate of Ammonia and 2 bags of Muriate of Potash (= 9 - I0) evenly mixed can be applied to your yams in two equal applications (i.e. on one hectare).

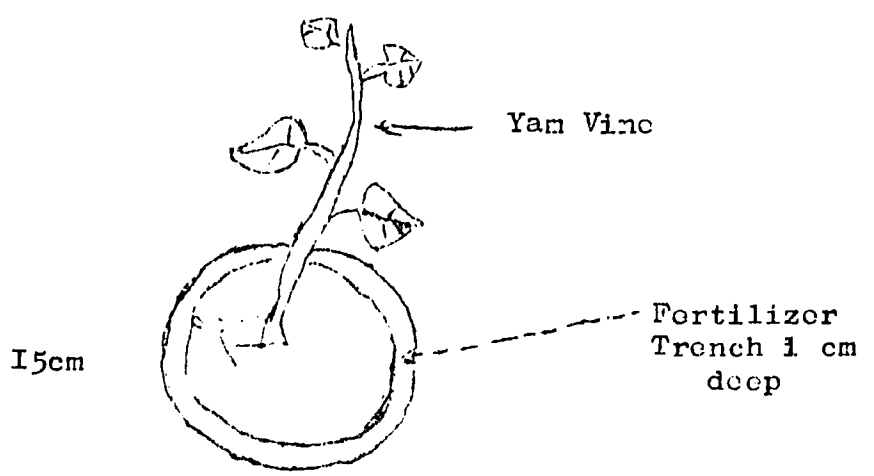
- First application after 80% of all the yams have sprouted usually about mid - March if planted latest mid - January i.e. 6 weeks after planting.
- Second application at the end of July i.e. 5 - 6 months after planting.

You apply 25 grammes/plant/application i.e. (5 beer caps).

HOW DO YOU APPLY YOUR FERTILIZER?

Make a small trenched ring around the stand, I5cm away and about 4cm deep and sprinkle the fertilizer evenly in it. Cover up the trench.

- Avoid spreading the fertilizer on leaves or placing it too close to the vine to avoid fertiliser burn.



W E E D I N G

Weed your farm at least three times in the growing season.

The first weeding should be done in April/May, the second weeding should be done in July before second fertilizer application. The last weeding around September/October. Weeds may be left on the furrow to rot or used for compost. Stubborn weeds like cemolina, roots of spear grass etc. should be removed from the farm and preferrably burnt.

DISADVANTAGES OF WEEDS

1. WEEDS ARE THIEVES

They steal plant food and moisture from the soil. Your yams need the food and moisture and without them the crop cannot do well. The weeds must be removed, because they badly reduce yields of your yams.

2. WEEDS HARBOUR THE ENEMIES OF YOUR YAMS

Weeds provide good shelter for any insects or rodents which can damage your yams.

3. WEEDS PREVENT VENTILATION OF YOUR FARM

Because of poor ventilation diseases can attack your yam crop particularly if the atmosphere is humid.

Weeding loosens the surface soil and admits air into the soil. This is good for your yam plant. Only shallow weeding is recommended for yam so as not to destroy the roots of the yam or to wound any developing tubers.

DISEASES AND PESTS

The most common diseases on yams are:

1. ANTHRACNOSE DISEASE. It attacks mainly the leaves giving them a spotty appearance. The leaf may turn completely brown and fall off.

   CONTROL: Spraying the yam with 4 1/2 kg of 'manesan' in 200 litres of water/hectare prevents this disease but does not cure it.

2. MOSAIC. This virus stunts the plants, the leaves become pale green with dark green along the veins. It is serious.

   CONTROL: Roguing of diseased plants and not using diseased material for setts may help.

3. DIE-BACK. This disease begins at the tips of the vines and the vines die-back.

   CONTROL: Uproot the affected plant and burn or bury deep.

...../.

4. TUBER ROT. This is particularly serious with stored Oshie yam and Batibo yam.

CONTROL: Store your yams in well ventilated barns and spread thinly on the floor or in the shelf.

- For seed yam spray the setts with 'manesan' 'cuproxan'. Use 1 (one) match box full to one gallon (4 1/2 litres) of water.

5. YAM BEETLE. This attacks the yams in the ground by burrowing into the tuber and reducing their quality. They are particularly serious in warm locations, and swampy areas.

CONTROL: Use Aldrin 2 1/2 dust at 2.5 kg per hectare. Also treat the setts with Aldrin before planting.

H A R V E S T I N G

WHEN SHOULD YOU HARVEST YOUR YAMS?

The time to harvest your yams will depend on the variety and the purpose for harvest.

Some yams like the Jakiri sweet yams can be harvested by August if planted in January.

The Oshie white yam is usually ready for harvest by November - December.

However, there is a practice known as "milking" whereby the farmer opens up the ridge and carefully cuts off the big tuber around July - August and leaves the plant to develop setts for next planting.

Some farmers harvest their yams one to two months earlier in order to catch the market. Yams harvested earlier than usual have a poor storage ability because of the high moisture content.

...../.

HOW SHOULD YOU HARVEST YOUR YAMS?

It is important to dig carefully and not to bruise or wound the tubers. Bruised or wounded tubers do not store well. Use a digger (tonkee) for efficiency. CENEEMA Bambui produces them at about 500 francs each.

S T O R A G E

Yams are better stored in a cool dry place and away from the rays of the sun. Yams should be stored in a way as to allow for free air-circulation around the yams.

Several ways of storing are possible:

a) packing tubers in ashes and covering them with soil;
b) covering the yams with a few inches of soil and a grass mulch;
c) piling the tuber in shapes like a pyramid, lining the floor and covering the clamps with old palm leaves, leaving a hole in the middle to allow air to circulate;
d) suspending yams singly from branches which shade them;
e) tying them to a framework of poles. This is perhaps the most popular and best way of storing yams.

...../.

COST OF PRODUCING ONE HECTARE OF YAM *

OPERATION / INPUTS	MAN-DAYS	FRANCS CFA
I. Clearing and Tillage ** (not mechanised)	60	2I,000
2. Seed bed Preparation a) Im x Im heaps or b) ridges Im apart — not mechanised	70	25.900
3. Seed yam preparation and planting	35	I2,250
4. Stakes (wooden) 3m high	89	3I,I50
5. Staking and training vines and removal of stakes after harvest	62	2I,700
6. Weeding (3x) and remoulding of Ridges	64	22,400
7. Fertilizer cost (500 kg)	-	20,000
8. Fertilizer Application (2x)	8	2,800
9. Harvesting	I00	35,000
I0. Repairing and tying in barn	30	I0,500
II. Cost of I0,000 yam setts @ 30 frs. each	-	300,000
T O T A L	533	525.700

Rate/Manday = 350 francs

Estimating a yield on the farmer's field of:

D. rotundata = I5 tons, break even = 36 frs/kg
D. cayenensis = I5 tons, " " = 36 frs/kg
D. dumetorum = 35 tons, " " = I5 frs/kg

* = These figures vary, and are only indicative and by no means fixed.

** = This refers to the grassland areas (Guinea highland savanna) of the North-West and Western Provinces.

APPENDIX F

Contract Between FONADER and Agents

NATIONAL FUND FOR RURAL DEVELOPMENT

B . P. 1548 - Tél.: 23 10 25 and 22 29 82 Telex 8365 KN

DIRECTION DES ETUDES ET OPERATIONS

CONTRACT FOR MANAGEMENT OF FERTILIZERS N° _____/DG/DEO.-

Between the National Fund for Rural Development, hereafter called FONADER represented by his General Director, on the one hand,
and

_____

_____ hereafter called Agent
represented by _____

_____ on the other hand:

Article 1. SUBJECT

FONADER delivers the following fertilizers for the 1984/1985 crop year to the Agent who accepts to take delivery and then distribute them to individual farmers and to the ones he is monitoring.

TYPE OF FERTILIZERS	QUANTITIES	OBSERVATIONS
N.P.K. 20.10.10.		
N.P.K. 12.6.20.		
S.A		
Urea		
Others		
_____		

Article 2. DELIVERY AND DESTINATION

The fertilizers are delivered in good condition to the stores belonging to the Agent who pledges to take delivery of them. For each delivery, he draws up an acknowledgement of receipt signed by the carrier.

Any delivery not conformant with the forwarding documents (damages or short deliveries) is subject to a written statement on the waybill by the Agent so that a deduction can be made on the carrier's payment..

Under Article 4 hereafter, para 2, the Agent is held responsible for any damages happening after the waybill has been signed.

Article 3. EVALUATION OF STOCKS

The value of the fertilizers delivered by FONADER to the Agent is established on the basis of the assignment price in force for the on-going crop year.

On this basis, the deposited fertilizer's value amounts to:

TYPE OF FERTILIZERS	UNIT PRICE (MT)	QUANTITIES	AMOUNT
N.P.K. 20.10.10.	35,000 40,000		
N.P.K. 12.6.20.	35,000 * 40,000 **		
S.A.	35,000 40,000		
Urea	35,000 40,000		
Others			
TOTAL			

* Carrying off from Douala: 35,000 francs/MT.

** Carrying off from the Provinces' Chefs lieux: 40,000 francs/MT (Agent)

Article 4. AGENTS'S LIABLITY

The Agent is responsible for the good management of the fertilizers' stocks entrusted to him by FONADER.

He has his storage facility insured against fire, theft and bad weather. The costs of insurance will be refunded up to 50 % to the Agent by FONADER upon presentation of vouchers .

The Agent is responsible for selling the fertilizers for cash to all farmers at the subsidized prices. However, he will be entitled to sell these fertilizers on credit to the farmers he is monitoring.

The Agent will establish at the end of every month the recap list of the fertilizers paid cash and of fertilizerd paid on credit. The total amount received for the sales paid cash must be remitted to the FONADER Agency within ten days following the end of the month, or otherwise the payment of a penalty of 1 % per month or per fraction of month will have to be made.

The sums due for the fertilizers selled on credit will have to be recovered at the end of the crop year by the Agent who will be held responsible for any unpaid debt. The sums thus recovered in the course of one month will have to be remitted to FONADER under the same conditions as mentionned above. The Agent will have to have the total value of the sales transfered to FONADER no later than April 15, 1986. Any payment made after that date will incur a penalty of 1 % per month or per fraction of the month.

Article 5. AGENT'S PAYMENT

In consideration of the Agent'a intervention in this operation, FONADER agrees to pay him 10 % of the sums he remitted to the local FONADER Agency.

This payment will be made every three months by the local FONADER Agency upon presentation by the Agent of the payments effected during said period.

Article 6. ENTERING RECORDS INTO ACCOUNT

a) The Agent keeps the monthly stock files up to date indicating each fertilizer movement (in, out, balance).

The Agent also keeps to date the monthly files of delivery and remittance of the sales'amount.

b) The Agent does not make any delivery nor any collection of money without establishing a duly signed voucher. These documents or copies of them will be kept at least until the debt is repaid to FONADER.

Article 7. RIGHT OF INSPECTION

The Agent recognizes to FONADER free access to all places where fertilizers are stored. In addition, FONADER will be given any document concerning the management of fertilizers.

Article 8. DISPUTE

Any dispute arising between the contracting parties under the execution of this Contract must be resolved by direct negociations between the parties in order to arrive at a mutual agreement. In the event that such agreement cannot be reached, the dispute shall be submitted to the competent autohority, FONADER headquarters, for final deliberation.

Done in Yaoundé, on

For FONADER,
Le Directeur des Etudes et Operations

For the Agent,

APPENDIX G

Typical Tender Document Used in 1985

NATIONAL CALL FOR TENDERS

CENTRAL CONTRACTS DEPARTMENT

MINISTRY OF COMPUTER SERVICES AND PUBLIC CONTRACTS

- Y A O U N D E -.

By public announcement for the supply of fertilizers for Industrial and Food Crops

PROGRAMME FINANCED BY FONADER ON BEHALF OF THE MINISTRY OF AGRICULTURE

1985/1986 CROP YEAR

PURCHASE OF THE BID DOCUMENTS: CFA 200,000

I. - CALL FOR TENDERS:

FOR: FERTILIZERS FOR FERTILIZATION OF ROBUSTA AND ARABICA COFFEE TREES, A NURSERY DEVELOPMENT AND ESTABLISHEMENT OF COCOA AND COFFEE TREES AND FERTILIZATION OF FOOD CROPS

INVITATION TO TENDER FOR THE SUPPLY OF:

A/ AMMONIUM SULFATE OR ANY OTHER SAME-TYPE SAME-EFFECT FERTILIZER.

A1. Definitions and Technical Specifications

Supply of a fertilizer (Ammonium Sulfate) containing 21 % nitrogen per gramme-molecule without any isomer. The product will be a white-colored, non-abrasive, crystalline powder that can be spread or sprayed, be well absorbed by the roots when melt in the soil solution.

A light percentage in the region of APPM isomer could be tolerated.

A2. Packing and Handling

The product will be delivered in 50 Kg net-weight bags, waterproof and double shelled. These bags must absolutely be made of burlap or of polypropylene lined with polyethilene, sewn on the two edges. The bags will be marked with the supplier's name by means of a good quality, air-, water- and handling-proof stuff.

In addition to the usual supplier's information, the words "Ammonium Sulfate" fertilizer will be written on the bags.

A3. Quantity

The quantities to order will be determined by the Central Contracts Department after review of the bids.

A4. Price bids

The bidder will make price bids by 5 000 MT successive stages taking care to stop at the level corresponding to his capacity.

He will also have to indicate the validity period for his bids.

Thus, the bids will be presented in the following way:

Lot of 5 000 MT	price
Lot of 10 000 MT	price
Lot of 15 000 MT	price

B/ N-P-K COMPLETE FERTILIZER, 20-10-10 FORMULA, OR ANY OTHER SAME-TYPE SAME-EFFECT FERTILIZER.

B1. Definitions and Technical Specifications

Supply of fertilizers in a granular form (non-agglomerated complete 20-10-10 fertilizer, with respectively 20 % nitrogen, 10 % phosphorous acid and 10 % potash in the formula per 100 gram product, soluble in water and, in particular, in the soil solution.

The nitrogen contents in the 20-10-10 formula must contain a portion in soluble ammonium nitrogen or ammonium citrate.

B2. Packing and Handling

The product will be delivered in 50 Kg net-weight bags, waterproof and double shelled. These bags must absolutely be made of burlap or of polypropylene lined with polyethilene, sewn on the two edges.

The bags will be marked with the supplier's name by means of a good quality, air-, water- and handling-proof stuff.

In addition to the usual supplier information, the words "Complete 20-10-10 N-P-K fertilizer" will be clearly written on the bags.

B3. Quantity

The quantities to order will be determined by the Central Contracts Department after review of the bids.

B4. Price bids

The bidder will make price bids by 5 000 MT successive stages taking care to stop at the level corresponding to his capacity.

He will also have to indicate the validity period for his bids.

Thus, the bids will be presented in the following way:

Lot of 5 000 MT	price
Lot of 10 000 MT	price
Lot of 15 000 MT	price
Lot of 30 000 MT	price

C/ UREA

C1. Definitions and Technical Specifications

Supply of a fertilizer component containing at least 46 % N in the form of amid. The product will be a white-colored, non abrasive crystalline powder or in a granular form of varying color that can be spread and/or sprayed (direct assimilation by the leaves). It may contain any other fertilizing component.

C2. Packing and Handling

The product will be delivered in 50 Kg net-weight bags, waterproof and double shelled. These bags must absolutely be made of burlap or of polypropylene lined with polyethilene, sewn on the two edges. The bags will be marked with the supplier's name by means of a good quality, air-, water- and handling-proof stuff.

In addition to the usual supplier's information, the words "UREA 46 %" will be clearly written on the bags.

C3. Quantity

The quantities to provide will be determined by the Central Contracts Department after review of the bids.

C4. Price bids

The bidder will make price bids by 5 000 MT successive stages taking care to stop at the level corresponding to his capacity.

He will also have to indicate the validity period for his bids.

Thus, the bids will be presented in the following way:

Lot of 5 000 MT	price
Lot of 10 000 MT	price
Lot of 15 000 MT	price
Lot of 20 000 MT	price

D/ N-P-K COMPLETE FERTILIZER, 20-10-10 FORMULA, OR ANY OTHER SAME-TYPE SAME-EFFECT FERTIILZER

D1. Definitions and Technical Specifications

Supply of a fertilizer in a granular form (non-agglomerated complete 12-6-20 fertilizer, with respectively 12 % nitrogen, 6 % phosphorous acid and 20 % potash in the formula per 100 gram product, soluble in water and, in particular, in the ground solution.

The nitrogen content in the 12-6-20 formula must contain a portion in ammonium nitrogen, 6 % P205 soluble phosphorous acid or ammonium citrate.

D2. Packing and Handling

The product will be delivered in 50 Kg net-weight bags, waterproof and double shelled. These bags must absolutely be made of burlap or of polypropylene lined with polyethilene, sewn on the two edges.

The bags will be marked with the supplier's name by means of a good quality, air-, water- and handling-proof stuff.

In addition to the usual supplier information, the words "N-P-K Complete fertilizer" will be written on the bags.

D3. Quantity

The quantities to order will be determined by the Central Contracts Department after review of the bids.

D4. Price bids

The bidder will make price bids by 5 000 MT successive stages taking care to stop at the level corresponding to his capacity.

He will also have to indicate the validity period for his bids.

Thus, the bids will be presented in the following way:

Lot of 5 000 MT	price
Lot of 10 000 MT	price
Lot of 15 000 MT	price
Lot of 20 000 MT	price

II. COMMON PROVISIONS FOR ALL PESTICIDS:

Each product will undergo an analysis made by a research organization hired by the Technical Commission at the time of the technical acceptance. This acceptance will be made by a competent Commission.

During the acceptance there will be a sampling, the analysis of which will aim at proving that the product's technical specifications are conformant with what was indicated on the Invitation for Bids.

The cost of forwarding and analysis of the sample will be borne by the supplier.

III. GENERAL CONDITIONS OF THE INVITATION FOR BIDS:

Bidders are to submit bids to the Ministry of Computer Services and Public Contracts, Central Contracts Department, Yaounde, in registred sealed envelops marked "Bids No _____ concerning the supply of fertilizers. To be opened only in a bid opening session".

They should be received no later than August 20, 1985 at 17 hours, local time; after this deadline, no bids will be accepted.

The envelop which will be opened during the Commission session should include:

1 - A declaration stating the intent to bid by which the candidate expressly accepts all the conditions of this Invitation for Bids and undertakes to adhere to them;

2 - A receipt from Treasury for the purchase of the bid documents;

3 - A certificate of non-bankruptcy established by the Greffe du Tribunal de Première Instance of the bidder's place of residence;

4 - Certification of a bank account in the name of the bidder;

5 - A certificate of nationality;

6 - A certificate from the manufacturer pledging to deliver the product to his representative in the Republic of Cameroon;

7 - The bidders residing in Cameroon will provide also:

a)- a proof signed by the Director of Taxes certifying that the bidder has filed the required declaration for taxes;

b)- a certificate signed by the Director of National Fund for Social Security and Workmen's Compensation (Caisse nationale de Prévoyance sociale) certifying that the bidder has effectively paid the sums he owes.

8 - Two sealed envelops:

a)- the first envelop will bear the inscription "Technical Specifications" and will include:

- an analysis certificate, a description of the product established by the bidder and signed by him, concerning especially the detailed technical characteristics about the proposed fertilizers;
- a copy of a technical report made by the Institute for Agronomic Research (IRA) for the proposed formula and not for the active component;
- a detailed description of the packaging.

b)- the second sealed envelop will bear the inscription "Price Offer" and will include the prices submitted at least in duplicate and provisional bid bond amounting to 10 % of the bid price of the contract.

These bids will relate to products matching exactly the conditions of this Invitation for Bids.

The bidder will remain bound by his bid for a period of 90 days from the date of opening of the envelops.

These price offers will be made in francs CFA, they will be firm and without reservation and are understood to be CIF.

The global price offers will have to be broken down in order to show each item making up the total price, with the corresponding cost - from the price ex works to delivery store.

In this breakdown everything must be listed: duty rights, taxes and various costs related to the signing of the Contract. Two price offers will then be made:

- C.I.F. price under tackle in Douala
- C.I.F. delivery cost including all expenses.

These price bids will be made according to an average price any destination.

Any bid non conformant with all the stipulated conditions herein will not be taken into account.

IV. SAMPLE:

Samples of the proposed product must be sent at the expense of the bidder to the Direction de l'Agriculture in Yaounde against receipt no less than three weeks before the date of bid opening for study and trials. These samples must be in adequate quantity, that is in 50 Kg bags corresponding to the required packaging.

The sample shoud bear very clearly the name and address of the supplier.

These samples will not be given back after analysis.

Failure to observe this condition leads to the rejection of the sample.

V. ACCEPTANCE:

The acceptance operations will be monitored by an appropriate commission.

For monitoring purposes, a sampling will be made on chance bags during the technical acceptance. This sample will be, at the supplier's expense, submitted to the Cameroon Ministry of Higher Education and Scientific Research laboratories for tests.

If a contestation should arise, a laboratory of arbitration will be designated by mutual agreement by the Direction of Agriculture and the supplier.

Any damaged bag will be rejected. Otherwise these replacements will give rise to the allowance provided for in case of delivery delay.

VI. BID BOND:

A bid bond calculated in the following way on the amounts of the contract must be constituted within 20 days following the contract award as a guarantee of the committments made by the successful bidder and will not be refunded until the last supply acceptance.

Less than 30 million:	2 %
between 30 to 50 million:	3 %
between 50 to 100 million:	4 %
above 100 million:	5 %

The Contractor shall be able to substitute a real personal bid bond with a personal bond backed by a bank or financial institution in accordance with the terms defined in the official texts.

VII. PAYMENT CONDITIONS:

The amount of the Contract will be paid to the Contractor according to the following conditions:

1)- 30 % at the signing of the Contract;
this advance amount will have to be 100 % guaranteed;

2)- 40 % at the provisional acceptance upon presentation of the record of provisional acceptance established in each delivery place;

3)- 30 %, i.e. the balance contingent or the conformity of the last acceptance with the analysis bulletin of the sample and of the packaging.

All payments will be in Francs CFA through a bank check payable to the Contractor.

VIII. RETENTION:

There will be a 10 % per cent retention from each invoice.

This retention may be replaced by a personal bank bond made the same way as the bid bond.

IX. PENALTIES:

a) Penalties for delay:

After 10 days, the Contractor shall be subject to a penalty deduction equal to 1/2000th of the initial amount of the contract per calendar day of delay up to and including the 15th day, and to a penalty deduction equal to 1/1000th of the initial amount beyond a 15 day delay.

Should the delay be more than a month, the Contract will be withdrawn. This penalty will be retained from the amount due under the Contract.

b) Penalties for non-compliance with the specifications and technical provisions:

For non-compliance with the specifications and technical provisions provided in the contract, the Contractor will have to replace any product which does not come within the requirements with a product up to the requirements in this Invitation for Tenders. At the same time, he will have to refund all the costs for the transportation of the fertilizers.

c) Penalties for damages:

Spoiled fertilizers spotted at the place of delivery shall be considered as missing and penalized for delay.

X. STAMPS AND REGISTRATION EXPENSES:

Stamp costs and registration expenses for seven (7) originals sets of the contract are to be borne by the Contractor in accordance with the Law.

It is reminded that this contract which is signed in order to execute a project under the Plan will be registered:

- at the rate of 2 % if its financing comes from a domestic source;
- at a fixed registration price if its financing is external in pursuance of Articles 110 and 121 of the Registration Code.

XI. OPENING OF THE BIDS:

The bids will be opened in Yaounde by the Commission Centrale des Marchés which will meet in private session.

Each contractor will have to make arrangements so as to avoid any delay caused by the postal services.

No claim from the Contractor will be admitted on this account.

The analysis bulletin and the packaging descriptions will allow bids deemed as technically insufficient to be rejected.

No information will be released to competitors about the other offers.

The Direction Centrale des Marchés reserves the right to ask to the bidder after opening of tenders any further information it needs as well as the right not to carry out the Invitation for Tenders if it deems it necessary.

XII. REGULATIONS:

For everything not contrary to the provisions of this Invitation for Tenders, the execution of the contract is subject to the law in force.

XIII. BID DOCUMENTS:

They can be consulted:

IN CAMEROON, AT THE:

1)- Central Contracts Department (Ministry of Computer Services amd Public Contracts);

2)- Ministry of Agriculture (Department of Agriculture) Tel.: 23-28-48 YAOUNDE;

3)- Direction générale du FONADER - BP 1548 YAOUNDE Tel.: 23-10-25 and 23-39-82.

OUTSIDE CAMEROON:

Cameroon Diplomatic Representatives at:
Paris, Bonn, Brussells, Rome, Moscow, London, Washington, Amsterdam, Peking, Lagos, Ottawa, Madrid.

A N N E X

DISTANCES BETWEEN DOUALA AND THE DIFFERENT PLACES INDICATED IN THE INVITATION FOR BIDS

DOUALA - YAOUNDE..... = 273 Km

DOUALA - ABONG-MBANG (par Yaoundé)..... = 506 Km

DOUALA - KUMBA..... = 126 Km

DOUALA - NKONGSAMBA..... = 143 Km

DOUALA - BAFOUSAM..... = 226 Km

DOUALA - BAMENDA..... = 346 Km

DOUALA - BANYO (par Bafoussam)..... = 549 Km

DOUALA - NGAOUNDERE..... = 890 Km

DOUALA - GAROUA..... = 1 200 Km

DOUALA - MAROUA..... = 1 399 Km

APPENDIX H

Prototype Product Specifications

A.I.D. Small Business Memo

Trade Information for American Suppliers

Issued By
DEPARTMENT OF STATE
Agency for International Development, Office of Small Business
Washington, D. C. 20523 Area Code 703 235-9156

SBM 82-3
September 7, 1982
(Supersedes SBM 77-3)
(M/L: 8-23)

AID FERTILIZER SPECIFICATIONS

The following specifications supersede the product and packing specifications for fertilizer contained in U.S. Agency for International Development (AID) Commodity Eligibility Listing, (TM 15:54) dated January 1, 1981, pages 61-92, and SBM No. 77-3 dated August 12, 1977. This revision includes minor changes in fertilizer specifications and significant additions to the inspection section.

****

I. FERTILIZER - GENERAL

A. AID financing for fertilizers normally is limited to products of U.S. source (000). From time to time, lack of access to requirements for specific products and/or other exigencies may necessitate off-shore procurement of limited quantities. For each purchase from a non-U.S. source, prior approval of the specific product, quantity, and source is required from AID/W - SER/COM.

B. AID finances only those fertilizers which conform to product and bagging specifications approved by AID.

C. Fertilizers conforming to the product specifications listed alphabetically (Part IV) and with bagging specificiations (Part V) are considered eligible. All fertilizers are subject to special provisions 42.

D. Requests for fertilizers not covered by the specification herein may be submitted through the U.S. AID Mission for review and possible approval by AID/W - SER/COM. All such requests must contain details covering the proposed product and/or bagging specifications and should justify the need for such material.

E. All invitations for bid covering fertilizers must be approved by AID/W SER/COM before official publication and/or release to the trade.

II. EVALUATION

A. Single-Nutrient Fertilizers

Fertilizers will be evaluated on the basis of the minimum guaranteed analysis in increments of one unit of Plant Nutrient (PN); e.g., triple superphosphate ranging from 46.00% to and including 46.99% P_2O_5 will be evaluated as 46%.

B. Multinutrient Fertilizers

Fertilizers must be guaranteed and will be evaluated only on the basis of the analysis requested in the tender; e.g., 18-46-0 will be evaluated as 18% nitrogen and 46% P_2O_5 or a total of 64 units of Plant Nutrient.

III. DISCOUNTS

A. Rates of Discount

When a shipment fails to meet the grade of Plant Nutrient as guaranteed, the following discount schedule will apply:

Deviation from Guaranteed Analysis	Adjustment Factor
When the deficiency of any nutrient guaranteed is 0.5 units or less.	0
When the deficiency of any nutrient guaranteed is more than 0.5, but less than 1.0 units.	2
When the deficiency of any nutrient guaranteed is 1.0 units or more	3

The above discounts will apply to each nutrient guaranteed. No allowance will be made for excess over guarantee of one nutrient to balance deficiency of another nutrient. Plant Nutrient value will be calculated on the basis of the contract price per ton of material.

B. Examples of Computation

1. Analysis of triple superphosphate guaranteed by the bidder is 46% on a lot of 1,000 tons priced at $175 per ton. Upon testing, the Plant Nutrient content was found to be 45.2% viz., deficiency was 46.0 - 45.2 = 0.8 of a unit. Price adjustment (discount) is computed as follows: 0.8 (unit deficiency) times 2 (adjustment factor) times $3.80 (Plant Nutrient value equals $175 divided by 46), times 1,000 (number of tons) equals $6,080 (discount). NOTE: "Price" for calculating discount is unit landed cost at foreign destination.

2. Analyses of 16-16-8 granular mixed fertilizer guaranteed by the bidder are 16% N, 16% P_2O_5, and 8% K_2O on lot of 5,000 tons priced at $160. Upon testing, the Plant Nutrients were found to be 15.3% N, 16.1% P_2O_5, and 8.8% K_2O, viz., deficiency was 16.0 - 15.3 equals 0.7 of a unit of N. Although both P_2O_5 and K_2O exceeded guarantee, no allowance is made for these excesses to balance the deficiency in N. Price adjustment (discount) is computed as follows: 0.7 (unit deficiency) times 2 (adjustment factor) times $4 (Plant Nutrient value equals $160 divided by 40), times 5,000 (number of tons) equals $28,000. NOTE: "Price" for calculating discount is unit landed cost at foreign destination.

C. Discount for Exceeding Chlorine Tolerance in Potassium Sulfate

Chlorine tolerance of 0.5% above specifications will be permitted without penalty. For every 0.5% in excess of this tolerance, a discount of 5% of the computed contract cost will be charged.

D. Non-Nutrient Deficiencies

Non-nutrient deficiencies include deficiencies in specified physical condition, packaging, labeling, particle size, moisture content, and others.

If, after inspection, the fertilizer is determined by the purchaser at the port of loading to be so deficient as to be unacceptable, the purchaser may decline to accept the commodity and exercise appropriate legal remedies. If, however, in spite of deficiencies the purchaser determines to accept the commodity, the purchaser shall be entitled, in any event, to a reasonable adjustment in the quoted landed cost for foreign destination.

IV. AID-APPROVED FERTILIZER SPECIFICATIONS

AMMONIUM NITRATE, - 33.5% GRADE (Schedule B. No. 480.6510)

Specification

Nitrogen content, total	33.5% as N, minimum
Moisture content	0.3% as H_2O, maximum
Coating	2.5%, minimum
Organic matter	0.1%, maximum
Screen size (Tyler)	minimum, 90.0% -6+16 mesh, 100.0% -4 mesh, 98% +28 mesh;
Physical condition	Prills or granules, free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Nitrogen, total	2.068
Moisture	2.013

Physical	TFI No.
Sieve analysis	IV. A.

AMMONIUM NITRATE, - PHASE STABILIZED (Schedule B, No. 480.6510)

Specification

Nitrogen content, total	34.0% as N, minimum
Moisture content	0.5% as H_2O, maximum
Stabilizer or additive	1.0%, maximum
Organic matter	0.1%, maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4 mesh, 98% +28 mesh;
Physical condition	Prills or granules, free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Nitrogen, total	2.068
Moisture	2.013

Physical	TFI No.
Sieve analysis	IV. A.

506

AMMONIUM SULFATE, STANDARD (Schedule B. No. 480.6525)

Specification

Nitrogen content	20.5% as N, minimum
Free acid content	0.10% as H_2SO_4, maximum
Moisture content	1.0% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6 mesh;
Physical condition	Coarse, crystalline or granular, free-flowing

Analytical Methods for Quality Control

Chemical	AOAC No., or as noted
Nitrogen	2.065
Free acid	Titration of 10% solution to methyl red end point with 0.1 N NaOH[a]
Moisture	2.012, dry at 129°-131°C to constant weight

Physical	TFI No.
Sieve analysis	IV. A.

[a] Reagent Chemicals and Standards, 5th Edition, Joseph Rosin, D. Van Nostrand Co. Inc., Princeton, NJ

AMMONIUM SULFATE, GRANULAR (Schedule B. No. 480.6525)

Specification

Nitrogen content	20.5% as N, minimum
Free acid content	0.10% as H_2SO_4, maximum
Moisture content	1.0% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6 +16 mesh, 100.0% -4 mesh, 98% +28 mesh
Physical condition	Coarse, crystalline or granular, free-flowing

Free acid	Titration of 10% solution to methyl red end point with 0.1 N NaOH[a]
Moisture	2.012, dry at 129° -131°C to constant weight

Physical	TFI No.
Sieve analysis	IV. A.

[a] Reagent Chemicals and Standards, 5th Edition, Joseph Rosin, D. Van Nostrand Co., Inc., Princeton, NJ

UREA, - 45% GRADE (Schedule B. No. 480.3000)

Specification

Nitrogen content	45.0% as N, minimum
Coating (clay, kieselguhr, talc, etc.)	1.0%, minimum
Biuret content	2.0%, maximum
Moisture content	0.5%, as H_2O maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4 mesh, 98% +28 mesh;
Physical condition	Prills or granules, free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Nitrogen	2.055, 2.056, and 2.057
Biuret	2.082, 2.083, and 2.084
Moisture	2.013

Physical	TFI No.
Sieve analysis	IV. A.

UREA, - 46% GRADE (Schedule B. No. 480.3000)

Specification

Nitrogen content	46.0% as N, minimum
Chemical Conditioner	
Methylenediurea (a product of the addition of a formaldehyde-based additive)	0.2% HCHO equivalent, minimum
Biuret content	2.0%, maximum
Moisture content	0.5% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4 mesh, 98% +28 mesh;
Physical condition	Prills or granules, free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No., or as noted
Nitrogen	2.055, 2.056, and 2.057
Biuret	2.082, 2.083, and 2.084
Moisture	2.013
Methylenediurea	Chromotropic acid[a]

Physical	TFI No.
Sieve analysis	IV. A.

[a] Formaldehyde, 3rd Edition, J. F. Walker, ACS Monograph, Reinhold Publishing Corp., New York, NY

UREA, - 46% N, LOW BIURET (Schedule B. No. 480.3000)

Specification

Nitrogen content	46.0% as N, minimum
Chemical conditioner	
Methylenediurea (a product of the addition of a formaldehyde-based additive)	0.2% HCHO equivalent, minimum
Biuret content	1.0%, maximum
Moisture content	0.5% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4, 98% +28 mesh;
Physical condition	Prills or granules, free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No., or as noted
Nitrogen	2.055, 2.056, and 2.057
Biuret	2.082, 2.083, and 2.084
Moisture	2.013
Methylenediurea	Chromotropic acid[a]

Physical	TFI No.
Sieve analysis	IV. A.

[a] Formaldehyde, 3rd Edition, J. F. Walker, ACS Monograph, Reinhold Publishing Corp., New York, NY

DIAMMONIUM PHOSPHATE, GRANULAR 18-46-0 GRADE (Schedule B. No. 480.8005)

Specification

Nitrogen content (nitrate free)	18.0% as N, minimum
Urea nitrogen	1.5% as N, maximum
Phosphorus content	
Available	46.0% as P_2O_5, minimum
Water soluble	39.1% as P_2O_5, minimum
Moisture content	2.0% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4 mesh, 98% +28 mesh
Physical condition	Granules, free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Nitrogen	2.055, 2.056, and 2.057
Urea	2.080 and 2.081
Phosphorus	
Total	2.026c, 2.027, and 2.028b
Citrate insoluble	2.044, 2.045, and 2.046
Available	2.048
Water soluble	2.040 and 2.041
Moisture	2.013

Physical	TFI No.
Sieve analysis	IV. A.

MONOAMMONIUM PHOSPHATE, GRANULAR 11-48-0 GRADE (Schedule B. No. 480.8015)

Specification

Nitrogen content (ammoniacal)	11.0% as N, minimum
Phosphorus content	
Available	48.0% as P_2O_5, minimum
Water soluble	40.8% as P_2O_5, minimum
Moisture content	2.0% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4 mesh, 98% +28 mesh
Physical condition	Granules, free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Nitrogen, ammoniacal	2.065
Phosphorus	
Total	2.026c, 2.027, and 2.028b
Citrate insoluble	2.044, 2.045, and 2.046a
Available	2.048
Water soluble	2.040 and 2.041
Moisture	2.013

Physical	TFI No.
Sieve analysis	IV. A.

MONOAMMONIUM PHOSPHATE, GRANULAR 13-52-0 GRADE (Schedule B No. 480.8015)

Specification

Nitrogen content (ammoniacal) . . .	13.0% as N, minimum
Phosphorus content	
Available	52.0% as P_2O_5, minimum
Water soluble	44.2% as P_2O_5, minimum
Moisture content	2.0% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6 +16 mesh, 100.0% -4 mesh, 98% +28 mesh
Physical condition	Granules, free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Nitrogen, ammoniacal	2.065
Phosphorus	
Total	2.026c, 2.027, and 2.028b
Citrate insoluble	2.044, 2.045, and 2.046a
Available	2.048
Water soluble	2.040 and 2.041
Moisture	2.013

Physical	TFI No.
Sieve analysis	XV. A.

MONOAMMONIUM PHOSPHATE, GRANULAR 11-52-0 GRADE (Schedule B No. 480.8015)

Specification

Nitrogen content (ammoniacal)	11.0% as N, minimum
Phosphorus content	
Available	52.0% as P_2O_5, minimum
Water soluble	41.6% as P_2O_5, minimum
Moisture content	2.0% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4 mesh, 98% +28 mesh
Physical condition	Granules, free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Nitrogen, ammoniacal	2.065
Phosphorus	
Total.	2.026c, 2.027, and 2.028b
Citrate insoluble	2.044, 2.045, and 2.046a
Available	2.048
Water soluble	2.040 and 2.041
Moisture	2.013

Physical	TFI No.
Sieve analysis	IV. A.

MONOAMMONIUM PHOSPHATE, RUN-OF-PILE 10-50-0 GRADE (Schedule B No. 480.8015)

Specification

Nitrogen content*(ammoniacal)	10.0% as N, minimum
Phosphorus content*	
Available	50.0% as P_2O_5, minimum
Water soluble	42.5% as P_2O_5, minimum
Moisture content	2.0% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6 mesh;
Physical condition	Free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Nitrogen, ammoniacal	2.065
Phosphorus	
Total	2.026c, 2.027, and 2.028b
Citrate insoluble	2.044, 2.045, and 2.046a
Available	2.048
Water soluble	2.040 and 2.041
Moisture	2.013

Physical	TFI No.
Sieve Analysis	IV. A.

* Nitrogen and P_2O_5 specifications on dry basis

TRIPLE SUPERPHOSPHATE, GRANULAR (Schedule B No. 480.7050)

Specification

Phosphorus content	
Available	44.0 to 46.%[a] as P_2O_5, minimum
Water soluble	75% of guaranteed P_2O_5, minimum
Free acid content	5.0% as H_3PO_4, maximum
Moisture content	4.0% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4 mesh, 98% +28 m
Physical condition	Granules, free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No. or as noted
Phosphorus	
Total	2.026c, 2.027, and 2.028b
Citrate insoluble	2.044, 2.045, and 2.046a
Available	2.048
Water soluble	2.040 and 2.041
Free acid	No. 16 Section XI (AFPC[b])
Moisture	2.013

Physical	TFI No.
Sieve analysis	IV. A.

[a] Offers should be made on guaranteed minimum and they will be evaluated on basis of lowest landed cost of P_2O_5

[b] Association of Florida Phosphate Chemists, Analytical Methods, 6th Edition (1980)

TRIPLE SUPERPHOSPHATE, RUN-OF PILE (Schedule B. No. 480.7050)

Specification

Phosphorus content	
Available	44.0 to 46.0%[a] as P_2O_5, minimum
Water soluble	75% of guaranteed P_2O_5, minimum
Free acid content	5.5% as H_3PO_4, maximum
Moisture content	6.0% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6 mesh
Physical condition	Free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No., or as noted
Phosphorus	
Total	2.026c, 2.027, and 2.028b
Citrate insoluble	2.044, 2.045, and 2.046a
Available	2.048
Water soluble	2.040 and 2.041
Free acid	No. 16 Section XI (AFPC[b])
Moisture	2.013

Physical	TFI No.
Sieve analysis	IV. A.

[a] Offers should be made on guaranteed minimum and they will be evaluated on basis of lowest landed cost of P_2O_5

[b] Association of Florida Phosphate Chemists, Analytical Methods, 6th Edition (1980)

POTASSIUM CHLORIDE, STANDARD (Schedule B.No. 480.5000)

Specification

Potassium content, soluble	60.0% as K_2O, minimum
Moisture content	0.5% as H_2O, maximum
Screen size (Tyler)	90.0% -10 mesh, minimum
Physical condition	Free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Potassium, soluble	2.102, 2.103, and 2.104
Moisture	2.012, dry at 129° -131°C for five hours

Physical	TFI No.
Sieve analysis	IV. A.

POTASSIUM CHLORIDE, COARSE (Schedule B No. 480.5000)

Specification

Potassium content, soluble	60.0% as K_2O, minimum
Moisture content	0.5% as H_2O, maximum
Screen size (Tyler)	90.0% as -6+28 mesh, minimum
Physical condition	Free-flowing

Analytical Methods for Quality Control

Chemical	AOAC No.
Potassium, soluble	2.102, 2.103, and 2.104
Moisture	2.012, dry at 129° -131°C for five hours

Physical	TFI No.
Sieve analysis	IV. A.

POTASSIUM CHLORIDE, GRANULAR (Schedule B. No. 480.5000)

Specification

Potassium content, soluble	60.0% as K_2O, minimum
Moisture content	0.5% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4 me 98% +28 mesh
Physical condition	Granular, free-flowing

Analytical Methods for Quality Control

Chemical	AOAC No.
Potassium, soluble	2.102, 2.103, and 2.104
Moisture	2.012, dry at 129° -131°C for five hours

Physical	TFI No.
Sieve analysis	IV. A.

POTASSIUM NITRATE, GRANULAR (Schedule B. No. 480.7500)

Specification

Nitrogen content	12.0% as N, minimum
Potassium content, soluble	44.0% as K_2O, mimimum
Moisture	0.3% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4 mesh, 98% +28 mesh
Physical condition	Granules free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Nitrogen	2.068
Potassium, soluble	2.102, 2.103, and 2.104
Moisture	2.012, dry at 129° -131°C to constant weight

Physical	TFI No.
Sieve analysis	IV. A.

POTASSIUM SULFATE, STANDARD (Schedule B. No. 480.5400)

Specification

Potassium content, soluble	50.0% as K_2O, minimum
Moisture content	0.5% as H_2O, maximum
Chlorine content	2.5% as Cl, maximum
Screen size (Tyler)	90.0% -10 mesh, minimum
Physical condition	Free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Potassium soluble	2.102, 2.103, and 2.104
Moisture	2.012, dry at 129° -131°C to constant weight
Chlorine	2.119 and 2.120

Physical	TFI No.
Sieve analysis	IV. A.

POTASSIUM SULFATE, GRANULAR

(Schedule B. No. 480.5400)

Specification

Potassium content, soluble	50.0% as K_2O, minimum
Chlorine content	2.5% as Cl, maximum
Moisture content	0.5% as H_2O, maximum
Screen size (Tyler)	minimum 90.0% -6+16 mesh, 100.0% -4 mesh, 98% +28 mesh
Physical condition	Granular, free-flowing

Analytical Methods for Quality Control

Chemical	AOAC No.
Potassium, soluble	2.102, 2.103, and 2.104
Moisture	2.012, dry at 129° -131°C to constant weight
Chlorine	2.119 and 2.120

Physical	TFI No.
Sieve analysis	IV. A.

SULFATE OF POTASH-MAGNESIA, STANDARD (Schedule B. No. 480.7500)

Specification

Potassium content, soluble	21.0% as K_2O, minimum
Magnesium content, water soluble . .	18.0% as MgO, minimum
Sulfur content	22.0% as S, minimum
Chlorine content	2.5% as Cl, maximum
Moisture content	0.5% as H_2O, maximum
Screen size (Tyler)	90.0% -10 mesh, minimum
Physical condition	Free-flowing, non-caking

Analytical Methods for Quality Control

Chemical	AOAC No.
Potassium, soluble	2.102, 2.103, and 2.104
Magnesium, water soluble	2.138
Sulfur total	2.A01[a]
Chlorine	2.119 and 2.120
Moisture	2.012, dry at 129° -131°C for five hours

Physical	TFI No.
Sieve analysis	IV. A.

[a] Journal of AOAC, 63, No. 4, 854-58 (1980)

SULFATE OF POTASH-MAGNESIA, GRANULAR (Schedule B. No. 480.7500)

Specification

Potassium content, soluble	21.0% as K_2O, minimum
Magnesium content, water soluble . . .	18.0% as MgO, minimum
Sulfur content	22.0% as S, minimum
Chlorine content	2.5% as Cl, maximum
Moisture content	0.5% as H_2O, maximum
Screen size	minimum 90.0% -6 +16 mesh 100.0% -4 mesh, 98% +28 mesh
Physical condition	Granular, free-flowing

Analytical Methods for Quality Control

Chemical	AOAC No.
Potassium, soluble	2.102, 2.103, and 2.104
Magnesium, water soluble . . .	2.138
Sulfur	2.A01[a]
Chlorine	2.119 and 2.120
Moisture	2.012, dry at 129° -131°C for five hours

Physical	TFI No.
Sieve analysis	IV. A.

[a] Journal of AOAC, 63, No. 4, 854-58 (1980)

GRANULAR MIXED FERTILIZER: ( )-( )-( ) GRADE
(CHEMICALLY OR PHYSICALLY MIXED) (Schedule B. No. 480.8025)

Specification

Nitrogen content . . . . . _____% as N, minimum

	% as N
Ammoniacal nitrogen	_____
Nitrate nitrogen	_____
Urea nitrogen	_____
Organic nitrogen	_____

Available phosphorus content . . . . . _____% P_2O_5, minimum
Potassium content . . . . . _____% K_2O, minimum
Secondary and micronutrients

Element	%
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Moisture content . . . . . _____% H_2O, maximum
Anticaking conditioner
_____ . _____% minimum
(Type)

Screen size (Tyler) . . . . . minimum 90% -6+16 mesh, 100% -4 mesh, 98% +28 mesh
Physical condition . . . . . Granules, homogenous, free-flowing, nonsegregating, non-caking

---

Tender to specify chemical or physical mix. If urea is included in physical mix, superphosphate or nitrates must not be included. Physical mixes must be made with due regard to particle size matching of ingredients.

Analytical Methods for Quality Control

Chemical	AOAC No.
Nitrogen	
Total	2.059 and 2.060, or 2.063 and 2.064
Ammoniacal	2.065
Nitrate	2.069
Urea	2.080 and 2.081
Phosphorus	
Total	2.026c, 2.027, and 2.028b
Citrate insoluble	2.044, 2.045, and 2.046a
Available	2.048
Potassium, soluble	2.102, 2.103, and 2.104
Secondary and micronutrients	
Calcium	2.121
Sulfur	2.A01[a]
Copper, iron, magnesium, manganese, and zinc	2.109-2.113
Boron	2.C01-2.C04[b]
Moisture	2.013

Physical	TFI No.
Sieve analysis	IV. A.

---

[a] Journal of AOAC, Volume 63, No. 4, 854-58, (1980)

[b] Journal of AOAC, Volume 65, No. 2, 450-51, (1982)

V. AID - Approved Bagging Specifications - Fertilizers

A. Outer Bags

1. Polypropylene Bags

a. Capacity

50-kg net or 100-lb net

b. Fabric

Bags shall be made of 100% ultraviolet-stabilized polypropylene resin with a weight of not less than 2.6 oz. per square yard and possess the properties described following test methods. The color shall be light tan or beige. A colored identification marker (yarn) shall be inserted in the weave by the fabric manufacturer. The identification marker is to be reported to AID.

The fabric forming the top or bottom of the furnished bags shall be a tucked selvedge or a natural selvedge containing not less than the number of ends prevalent in the body of the fabric. Alternatively, the selvedge may be heat cut and formed a minimum of 1-inch wide with a minimum of 20 warp threads per inch.

The fabric must be woven to a construction tight enough to prevent excessive product sifting in the event bag liner failure occurs. The bottom seam is to be flat sewn in accordance with Federal Standard 751a, SSa-1, regardless of heat cut or tucked selvedge fabric. The side seam "Export Type" shall be in accordance with Federal Standard 751a, SSd-1. Bags shall be turned so seams are inside. The sewing thread shall be U.V. stabilized, polypropylene nominal 1000 denier with test strength of 5 grams/denier. There is no thread color requirement.

c. Test Methods

Ultraviolet stability test: Material and thread must have not less than 70% strength retention after 200 hours exposure in weatherometer. The U.V. testing weatherometer exposure method is 5804 Federal Standard 191.

Tensile Strength: Strength warp and fill, each 105 lbs. average. (10 samples shall be tested in each direction) with no single test below 90 lbs.) ASTM Method D-1682 (Grab Method)

Permeability: Air permeability of the fabric in an unstressed state should not exceed 100 cubic feet per minute per square foot. ASTM Method D737-75.

2. Jute Bags

a. Capacity

50-kg net or 100 lb. net

b. Fabric

New fabric shall weight 9 ounces per square yard (305 grams per square meter) 11 porter into 12 shot Hessian, or heavier.

B. Liner (Inner Bag)

Inner loose tubular liner shall be of 4 ml polyethylene film. The liner shall be heat-sealed at the bottom. The film shall be of low slip plastic.

Test Methods

1. Thickness--ASTM, D374. 4-ml polyethylene film.

2. Impact resistance--ASTM, D1709. An impact failure weight of 165 g.

3. Kinetic coefficient of friction--ASTM, B1894 (kinetic coefficient of friction 0.8 m/s maximum.)

C. Methods of Closure

1. Outer Bag

Top seam stitching shall be a minimum of one inch from the selvedge. The sewing thread shall be 200 hours U.V. stabilized, polypropylene nominal 1000 denier with test strength of 5 grams per denier. There is no thread color requirement. The outer bag shall be sewn above--not to the liner.

2. Liner

The polyethylene liner shall be closed at the top by one of the following methods after exhausting the excess air:

a. Heat sealing

b. Mechanically applied acid resistant clip of 0.150 inch minimum diameter (9 gauge) completely circling the polyethylene liner to hermetically seal it.

c. Mechanically applied bag tie 4½ inches long, plastic-covered wire with a 3/8 inch inside loop on each end. The wire shall be a minimum of 17 gauge before being covered with plastic to a minimum of 16 gauge.

d. For valve type bag, see alternative below.

D. Valve Type Bags as an Alternative-Bag Construction

Bags submitted under this performance specification shall perform as well as those made under existing specifications (paragraph V. A. - V. C. herein) with respect to closures, retention of printed information and resistance to snags, tears, and water vapor transmission.

1. Capacity

50-kg net or 100-lb net

2. Outer Bags

Bags must be manufactured from polypropylene or jute fabric meeting specifications stated in paragraph V. A. herein, except in valve bag, top and bottom will be folded seam double selvedge per Federal Specifications S/S-N-1. The side will be folded seam double, raw per Federal Specifications S/S-N-1.

3. Liner (Inner Bag)

Liners must be manufactured from polyethylene film meeting specifications stated in paragraph V. B. herein, except film is strip laminated to fabric and is folded over top, bottom, and edge with fabric.

4. Impact Resistance

All bags, including inserted film liners, shall be capable of withstanding the following performance test for impact resistance:

a. Ten filled and sealed bags containing the product to be shipped or an equivalent in specific gravity and general physical characteristics must each survive a single drop on the butt or bottom, on a shock machine that produces for each test a velocity change of 195 inches per second using a shock duration of .002 seconds without loss of product. Ten (10) bags constitute a test lot and all ten (10) bags must meet the minimum impact specified without a single failure.

b. Test shall be conducted under standard temperature (73.4 degrees F plus or minus 1.8 degrees F) and relative humidity (50% plus or minus 2%) conditions.

c. Filled bags must be placed in the conditioned atmosphere for sufficient time before the tests are conducted for the bags to come to equilibrium.

5. Sifting

Valve bags including inserted film liners shall be capable of withstanding the following test for sifting. Testing of filled and sealed bags is to be performed on a variable frequency vibration table (1g input) from 2.5 to 30 hz and sifting observed at the

frequency (ies) where the most violent bouncing occurs. Loss of product from the valve bags, due to sifting, shall be no greater than 0.5% of net weight filled.

6. Independent laboratories known to be capable of conducting the above impact resistance and sifting tests are:

MTS Systems Corporation Box 24012 Minneapolis, MN 55425	(612) 937-4000
Lansmont Corporation P. O. Box 1390 Montery, CA 93940	(408) 373-4791
Rutgers University Packaging Science and Engineering Department P. O. Box 909 Piscataway, N.J. 08854	(201) 932-3679
Bemis Company, Inc. P. O. Box 568 Peoria, IL 61601	(309) 682-5406
Michigan State University School of Packaging East Lansing, MI 48824	(517) 355-9580
Owens-Illinois, Inc. P. O. Box 1035 Toledo, OH 43666	(419) 247-5000

7. Valve type bags <u>are not acceptable</u> for ammonium nitrate or urea.

VI. INSPECTION AND SAMPLING

A. Responsibility

1. A "Certificate of Inspection and Approval" must be issued for each shipping lot by an independent inspection firm acceptable to AID, unless independent inspection is waived by the purchaser with AID's prior approval. In the event Purchaser elects not to inspect the fertilizer, as this determination requires AID/W approval, they shall provide to Supplier written waiver of its right to such inspection, duly executed by Purchaser or its agent. Said waiver shall be delivered to Supplier prior to sailing date of the shipment concerned.

2. The inspections shall be performed and reported in accordance with the instructions in the following sections VI.B, C, and D.

3. Independent inspections shall not be performed if the supplier's test shows that the contracted commodity specifications were not met in full.

4. The supplier shall arrange and grant the independent inspection firm any and all reasonable access to the commodity for the purpose of conducting all inspections and tests. The supplier shall notify the inspection firm by telephone, and confirm by telegram, or letter, at least ten days before commencement of bagging, that the fertilizer is ready for inspection. If the supplier has not met the contracted commodity specifications, the inspection firm shall not issue any certificate, and shall notify the purchaser, the supplier, and AID, Washington, at once.

B. Instructions--Inspection

The inspection firm shall:

1. Verify that the vessel holds are clean, dry, and ready to receive the cargo.

2. Verify that the specified weight of cargo is loaded aboard the ocean vessel.

3. Verify that loading is ceased during inclement weather or for any other reasons which may damage the cargo, and that stowage will not damage the cargo, or result in discharging difficulties.

   (Should the conditions of items 1, 2, or 3 not be met, the inspector will notify immediately the purchaser, supplier, the ship's captain and AID/SER/COM/CPS.)

4. Examine bags and report, if true, that the bags appear to meet specifications upon visual inspection. In addition, they shall verify that the export shipping marks are in accordance with the terms of the contract.

5. Sample, prepare, distribute, and furnish analyses of samples as prescribed in Sections IV. and VI C. Make the weight determination prescribed in Section VI. E.

6. Furnish documentations and notifications of inspections as prescribed in Section VI. D., this document.

7. If inspection and/or analysis reveal any deviation between the actual commodity or commodities and the specifications as stated in the IFB, the inspection firm must notify the Purchaser, Supplier, and A.I.D./SER/COM/CPS of such discrepancies immediately.

C. Instruction--Collection, Preparation and Distribution of Official Samples

1. The official samples shall be taken at the last point where the material is handled prior to ship loading. The inspection firm is required to draw the official samples itself, and arrange laboratory analysis of same in accordance with procedures specified herein. Bagged material shall be sampled periodically at the time of bagging before the bag is closed whenever possible. Bulk material shall be sampled progressively during the entire time of loading onto the vessel.

2. The inspector shall be responsible for making arrangements with the bagging firms to follow the sampling procedures as indicated below.

3. The official samples obtained by the following procedures may be used in the event of a dispute regarding quality of commodity.

4. Sampling

a. Bagged Fertilizer

Sampling shall be done at unannounced times, but at intervals not exceeding eight hours bagging time.

Closed Bags--Material shall be sampled as specified by TFI Method I.C.1. and the number of bags to be sampled is specified in the Sampling Schedule 3. The punctured bags should be neatly patched with printed labels, pressure sensitive tags, or special patching material.

Open Bags--Material shall be sampled by taking cup samples from the bags before they are closed. The samples shall be taken during random visits to the bagging operation to insure representation of the entire lot. The number of bags to be sampled is specified in the following Sampling Schedule 3.

b. Bulk Fertilizer

When available at the loading port, the automatic sampling system for fertilizer materials shall be used. Otherwise, if possible, bulk materials shall be sampled from a transfer belt in accordance with TFI Method I.C.2., procedure 1.a. Where stream-cutting is not possible, sampling shall be done at equally spaced intervals from random points on the belt immediately following and as close to a belt discharge as safety will permit, all increments being of approximately

equal size. The number of increments to be taken is specified in the following Sample Schedule.

c. Sampling Schedule

Where stream-sampling is not feasible as a means of obtaining official fertilizer samples, the following guide for sampling bagged or bulk materials shall be followed:

Consignment		No. of bags to be sampled or increments to be taken
Tons	Thousands of bags	
Under 500	Under 10	60
501-1000	10 - 20	80
1001-5000	21 - 100	100

5. Sample Preparation

Consolidations of increment samples into the gross sample and sample reduction by riffling shall be by the official inspector in accordance with TFI Method I.C.3. Procedure A. All samples must be kept in covered moisture-proof containers except when being added to the containers or being reduced. Final preparation of sample for chemical analysis shall be according to TFI Method I.C.3 procedure B.

6. Distribution of Official Sample

The official consolidated sample shall be divided into four equal parts, prior to grinding, by means of riffling using the procedure specified in Sample Preparation. One of the four parts shall be analyzed by the official inspector either in his own laboratory or another laboratory acceptable to the Buyer and A.I.D. Another part is made available to the seller upon request, and the remaining two such parts shall be retained by the official inspector for a minimum period of twelve months for possible use by a third referee chemist in the event of a dispute, or for reserve purposes. (In the case of an off-shore supplier, one of the two reserve portions shall be returned to an accepted U.S. laboratory for verification of analytical results.) Regarding commodity shipped from non-U.S. sources, if no independent laboratory acceptable to A.I.D. is available locally, the inspection firm must air mail its consolidated, official sample (s) to an alternative laboratory acceptable to A.I.D. NOTE: Analyses performed in the Manufacturer's laboratory under the inspection firm's supervision are an unacceptable substitute for the inspection firm's own sampling and chemical analyses.

7. Collection of Bag Samples

The inspector shall obtain at least four of the outer bags and of the liners being used and retain such bags for twelve months.

D. Manuals

Each product specification includes, under the heading "Analytical Methods for Quality Control," precise analytical methods for checking compliance with AID specifications. Unless otherwise indicated, the numerical citations shown for chemical requirements refer to analytical methods in the 13th Edition (1980) of the Association of Official Analytical Chemists (AOAC) manual, Official Methods of Analysis. Citations for physical requirements refer to the 4th Edition (1982) of The Fertilizer Institute (TFI) manual, Fertilizer Sampling and Analytical Methods. Both manuals are well known to persons in the United States and abroad who work with agricultural chemicals. The AOAC manual may be obtained from the Association of Official Analytical Chemists, 1111 North 19th Street, Arlington, Virginia 22209. The TFI manual may be obtained from the Fertilizer Institute, 1015 18th Street, Northwest, Washington, D.C. 20036.

E. Weight Determination

1. The independent inspection firm shall attest, on or prior to the date of the Bill of Lading, as to the weights of the commodity or commodities described in the invoice.

2. On bulk fertilizer the inspector is responsible for checking scales for calibration and weight verification. If scales are not available, weight should be verified from actual tare weights of hopper cars. If loading is directly from barges, or from stockpile, weights should be established by means of light and heavy draft survey of vessel.

3. On bagged fertilizer the inspector shall check the bagging scales and tare weights at intervals not to exceed 16 bagging hours. Inspector shall also spot check bagged material already stockpiled in the warehouse at intervals not to exceed 8 bagging hours. For purposes of check-weighing, an accurate platform scale adjacent to the bagging line should be maintained, kept clean and in balance. The inspector shall see that scales are checked at intervals during bagging and shall reweight bags periodically during the operation, keeping a record of these weight checks.

F. Instructions--Documentation

1. Within ten days of final sampling and completing the weight verification, and concluding that the identified shipping lot has met all of the commodity requirements, the inspection firm shall issue its "Certificate of Inspection and Approval" to the Purchaser, Seller, A.I.D., and others that may be designated. The certificate issued in the name of the purchaser must be transmitted immediately to the supplier.

The following is a suggested format for the "Certificate of Inspection and Approval"

Certificate of Inspection and Approval

Purchaser	-	B/L No.	-
Supplier	-	AID No.	-
Commodity Name/Grade	-		-
Metric Tons	-	Laboratory Report	-
Ocean Carrier	-	Certificate of Weight Verification	-

The "Certificate of Inspection and Approval" shall comprise of a narrative describing the inspection events in sequence. Where laboratory analyses are included in the commodity specifications, the inspection certificate must include actual laboratory results for each required test. If the commodity or commodities meet the specifications without exception, the inspector shall conclude his report stating, if true:

> "We attach our 'Laboratory Report, and Certificate of Weight Verification,' each containing an attestation confirming the supplier's conformance to the contracted commodity specifications. On the basis of inspections and tests we conducted in accordance with our contract and the aforesaid attestations, we certify and confirm that the subject shipping lot meets all of the commodity, bagging, marking, and weight requirements stipulated in the contracted commodity specifications."

2. The "Laboratory Report" so labeled shall:

   a. Identify the supplier's contract with the purchaser.

   b. Identify the shipping lot tested and analyzed.

   c. State the contracted commodity specifications, and the laboratory's corresponding analysis of the fertilizer, and shall if true,

   d. Attest that through use of the testing procedures stipulated in the Section above, and other means available to it, the fertilizer met the stated commodity specifications.

The "Laboratory Report" shall be issued in the name of the purchaser and be dated and signed by an executive authorized to bind the laboratory and/or the inspection firm.

3. The "Certificate of Weight Verification," so labeled, shall be issued by the inspection firm under its letterhead, and be dated and signed by an executive authorized to bind the firm. The certificate shall state in so many words the date the data were taken and the number and weight of unbroken bags duly filled with fertilizer delivered to the ocean carrier, or in the case of bulk goods, contain an attestation from the weighmaster at the port as to the weight loaded aboard ship.

4. The "Certificate of Inspection and Approval" shall be typewritten under the letterhead of the U.S. inspection firm, and shall be dated and signed by an officer authorized to bind the firm. The certificate shall contain no exculpatory provisions exempting the inspection firm from the performance of its contracted obligations. Provision of inspection services by an independent inspection firm shall not relieve the supplier from his responsibility to assure that he has inspected and tested the shipping lot before calling for inspection, nor from his responsibility to assure that each lot has met the specifications of the commodity contract.

VII. INSPECTION CLAUSES FOR PROCUREMENT DOCUMENTS

A. When inspection is arranged by the Supplier:

1. Fertilizer inspection and weight determination will be performed by an independent inspection firm for the account of the supplier in accordance with specifications set forth herein.

2. The cost of inspection and certification of weight must be included in the offered price.

3. Certificate of Inspection and Approval issued by any of the independent inspection firms listed in the IFB will be accepted. Bids must include the name of the inspection firm choosen, and the name of the laboratory to be used if other than its own.

4. Suppliers wishing to use inspection firms other than those shown herein must receive prior approval from A.I.D., SER/COM/CPS, in Washington, D.C. before the use of another firm.

B. When inspection is arranged by the Purchaser:

1. The cost of inspection and certification of weight is for the account of the Purchaser and is not to be included in the offered price.

2. Purchaser at its sole cost and expense shall have the right to inspect the fertilizer at all reasonable times prior to shipment thereof. Supplier agrees to grant Purchaser's Agents and representatives any and all reasonable access for the purpose of inspection at Supplier's plant, and at Supplier's subcontractor's plant, if any. Purchaser will provide the Supplier with the name and address of the firm which will perform the inspection services on Purchaser's behalf.

3. Certificate of Inspection and Approval will be issued by one of the independent inspection firms listed in the IFB, or other firm having prior approval of A.I.D.

4. Inspection will be performed by the independent inspection firm in accordance with the specifications set forth herein.

APPENDIX I

Some Criteria for Retailer Selection

Criteria for Retailer Selection

1. Have the ability to sell.
2. Have respect within the local agricultural community.
3. Have sufficient financial resources to operate the fertilizer component of his business.
4. Pay cash for fertilizer purchases.
5. Make sales from sale points within an assigned area as agreed upon authorized by the marketing organization.
6. Agree to purchase fertilizer during the off-season and make storage available to the marketing organization.
7. Have storage capacity for at least 50% of annual sales and be capable of receiving 30-ton lots.
8. Agree to forecast consumption by product, by month, and by sales outlet.
9. Agree to purchase in each calendar year a specified tonnage of each product.
10. Agree to maintain adequate stocks of the specified product at each of the sales points and not allow stock to become less than that required to meet demand during a 30-day period in the consuming season.
11. Agree to not tamper with the grades, trademarks, and packaging of the fertilizers as marketed by the marketing company at the time of deliveries.
12. Assist farmers in obtaining credit whenever possible.
13. Agree to place orders with the marketing organization for dispatch at least 2 months prior to the request date of dispatch.
14. Agree to sell for not more than the fixed retail prices.
15. Agree to make a concerted effort to maintain and increase fertilizer sales in the assigned area, including the following activities.
    a. Employ supervisory and sales personnel for the marketing of fertilizers.
    b. Carry out after-sales service prescribed by the marketing organization.
    c. Make full and proper use of the advertising and sales promotional material supplied by the marketing department and assist with the marketing department's sales promotion activities, i.e., field demonstrations, field days, farmer meetings, sales campaigns, and crop production contests.
16. Agree to display in a prominent place within the physical facilities the official retail price per ton/per bag for each product offered for sale.

17. Agree to attend and to send supervisory sales personnel to training meetings provided by the company.
18. Agree to maintain records of stocks, purchases, and sales of fertilizers as may be prescribed and share the information with the company.
19. Have a good knowledge of agriculture and be able to make farm visits and converse with the farmers.
20. Sell other essential crop production inputs.

APPENDIX J

Rainfall Patterns in Cameroon

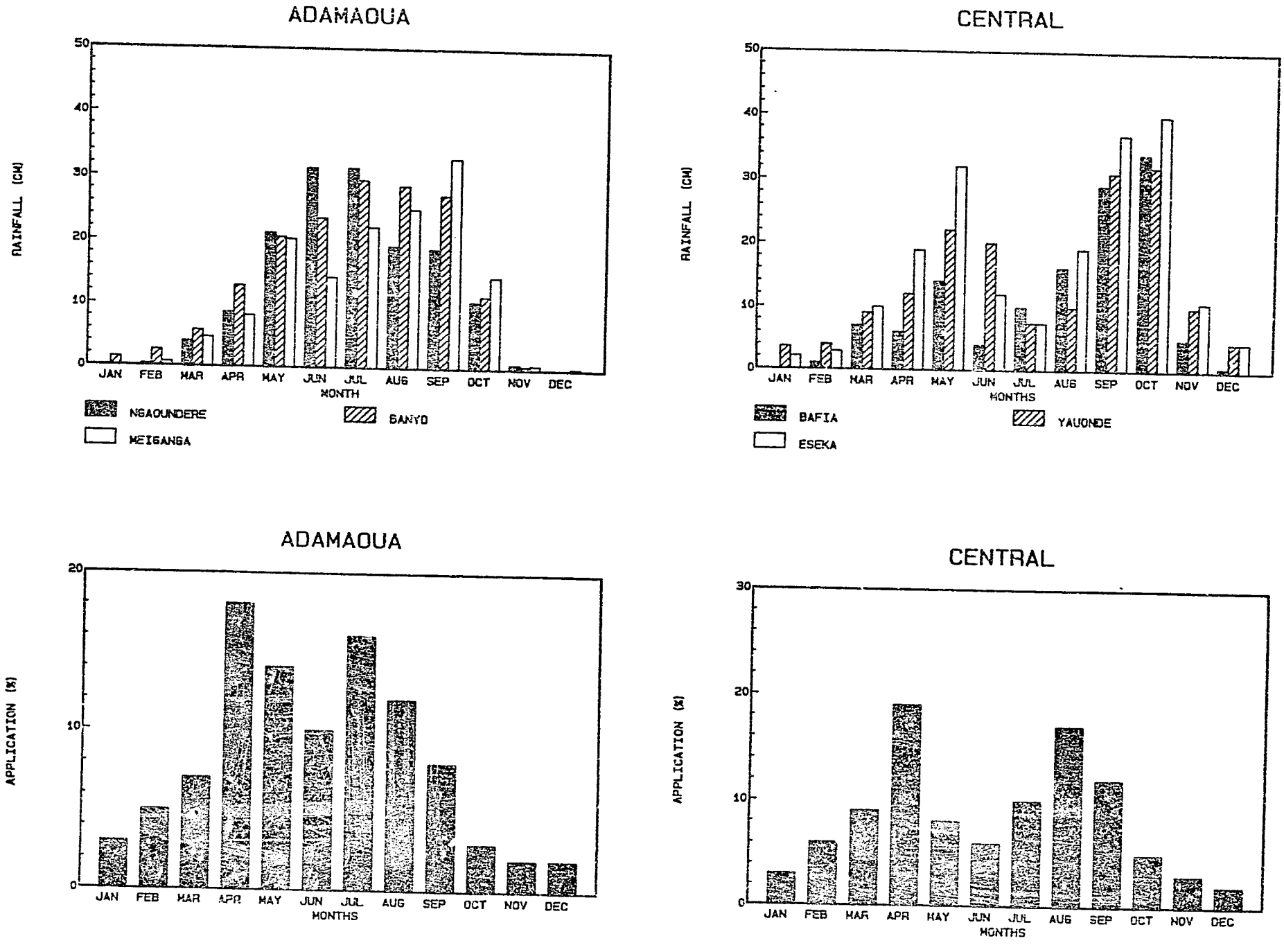
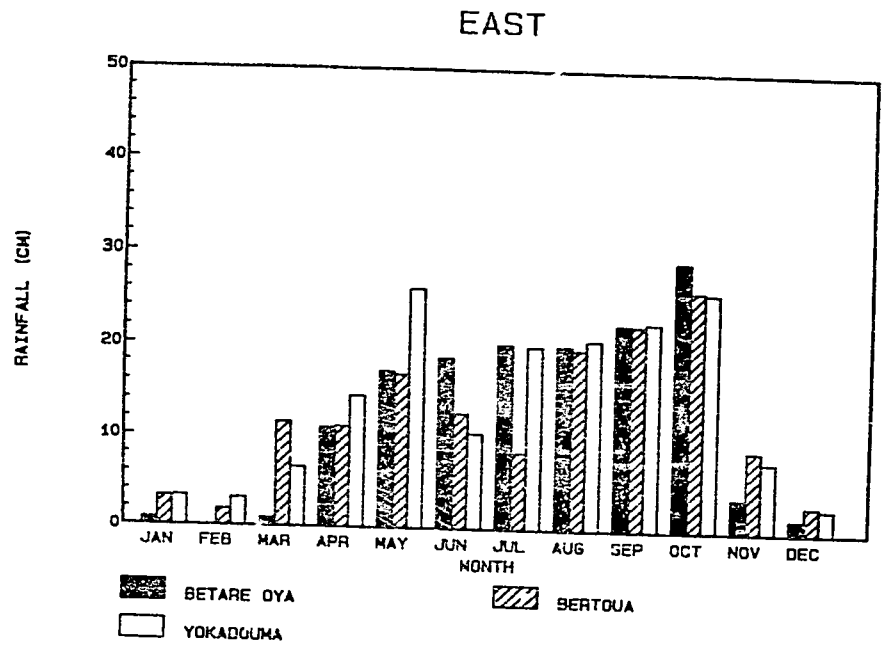
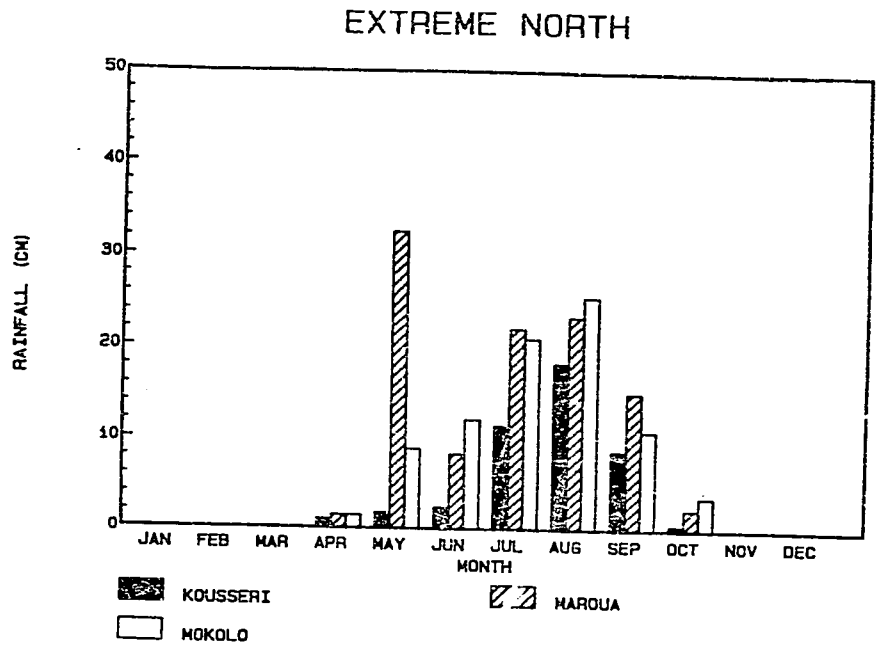
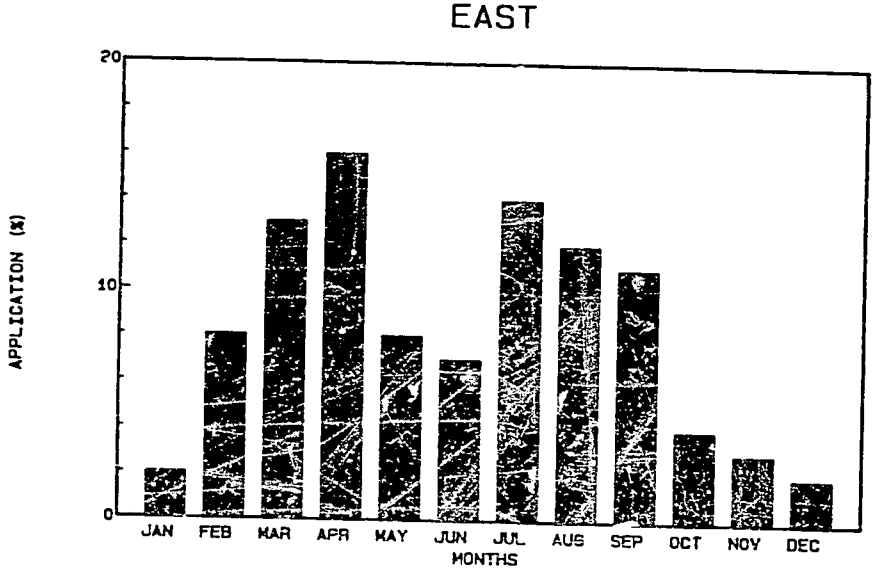


Figure . Rainfall Pattern and Fertilizer Application by Provinces in Cameroon.







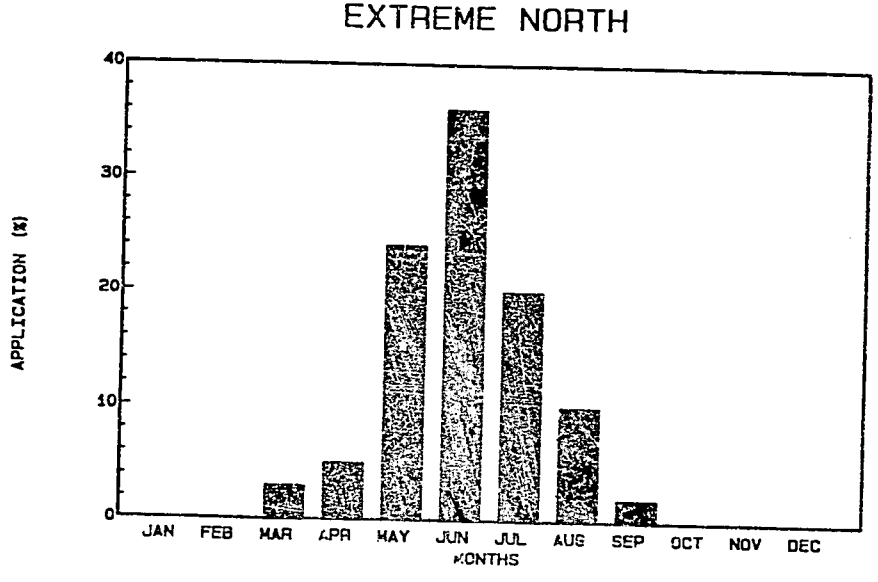


Figure . Rainfall Pattern and Fertilizer Application by Provinces in Cameroon (Continued).

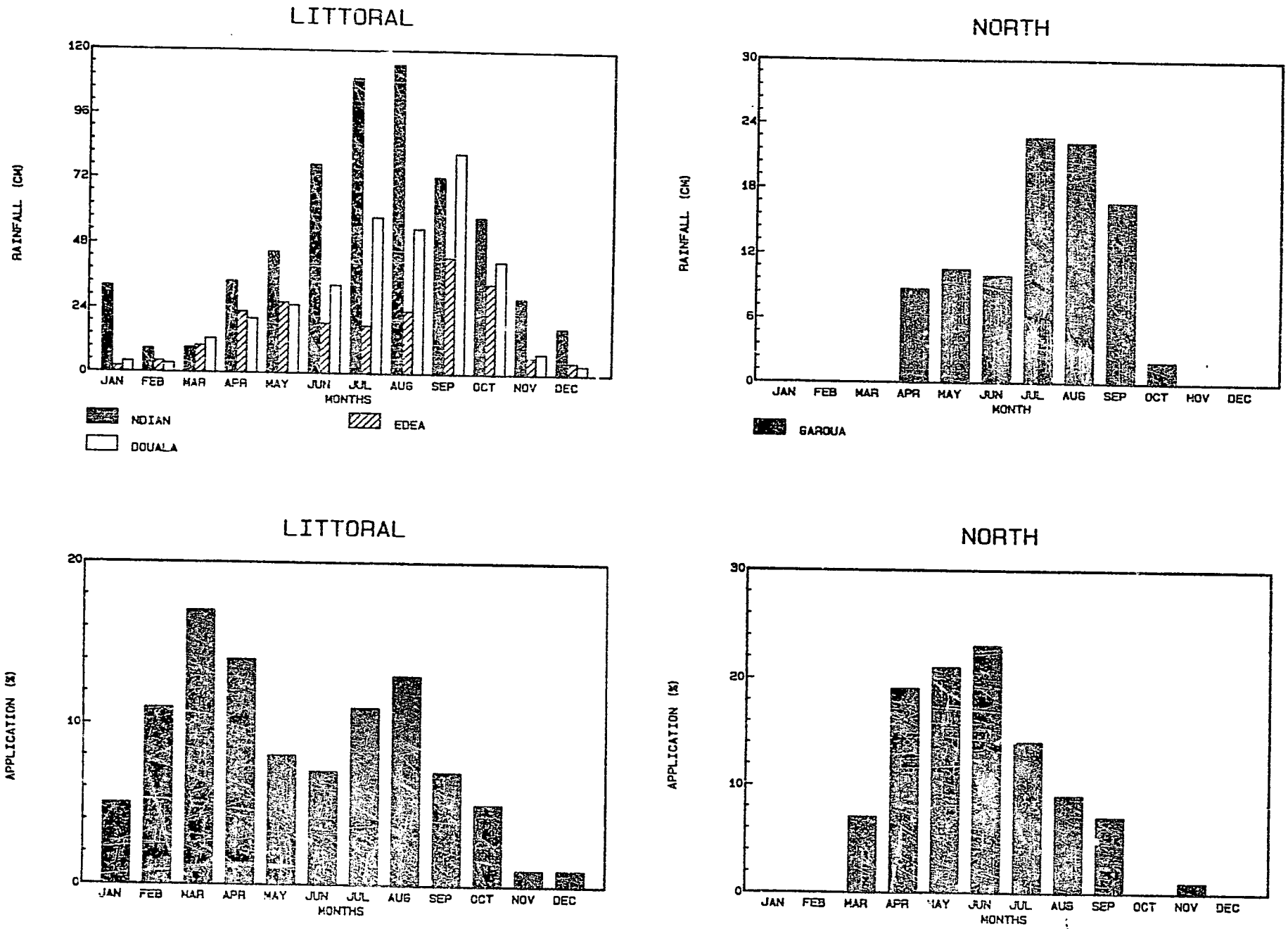


Figure . Rainfall Pattern and Fertilizer Application by Provinces in Cameroon (Continued).

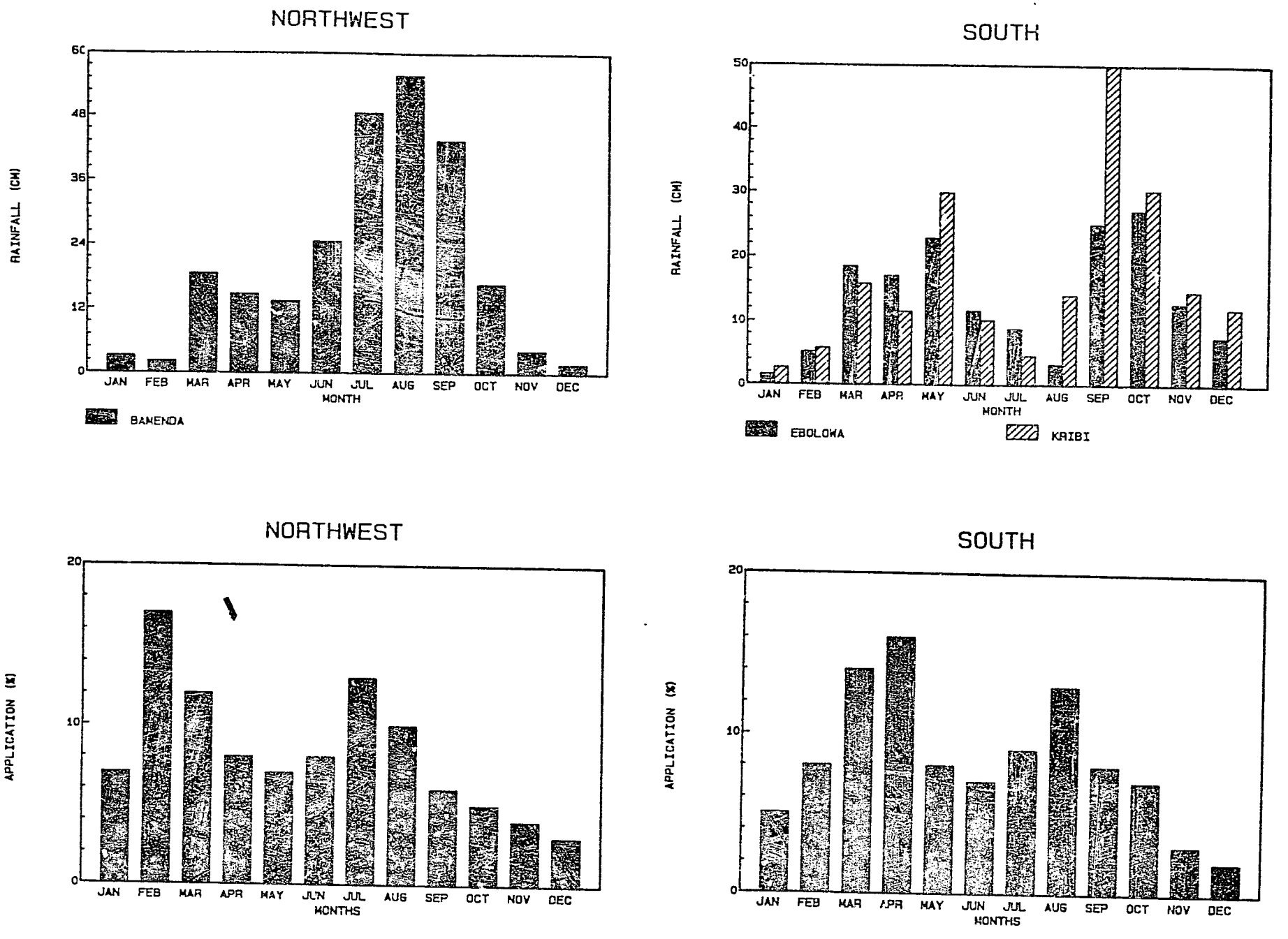


Figure . Rainfall Pattern and Fertilizer Application by Provinces in Cameroon (Continued).

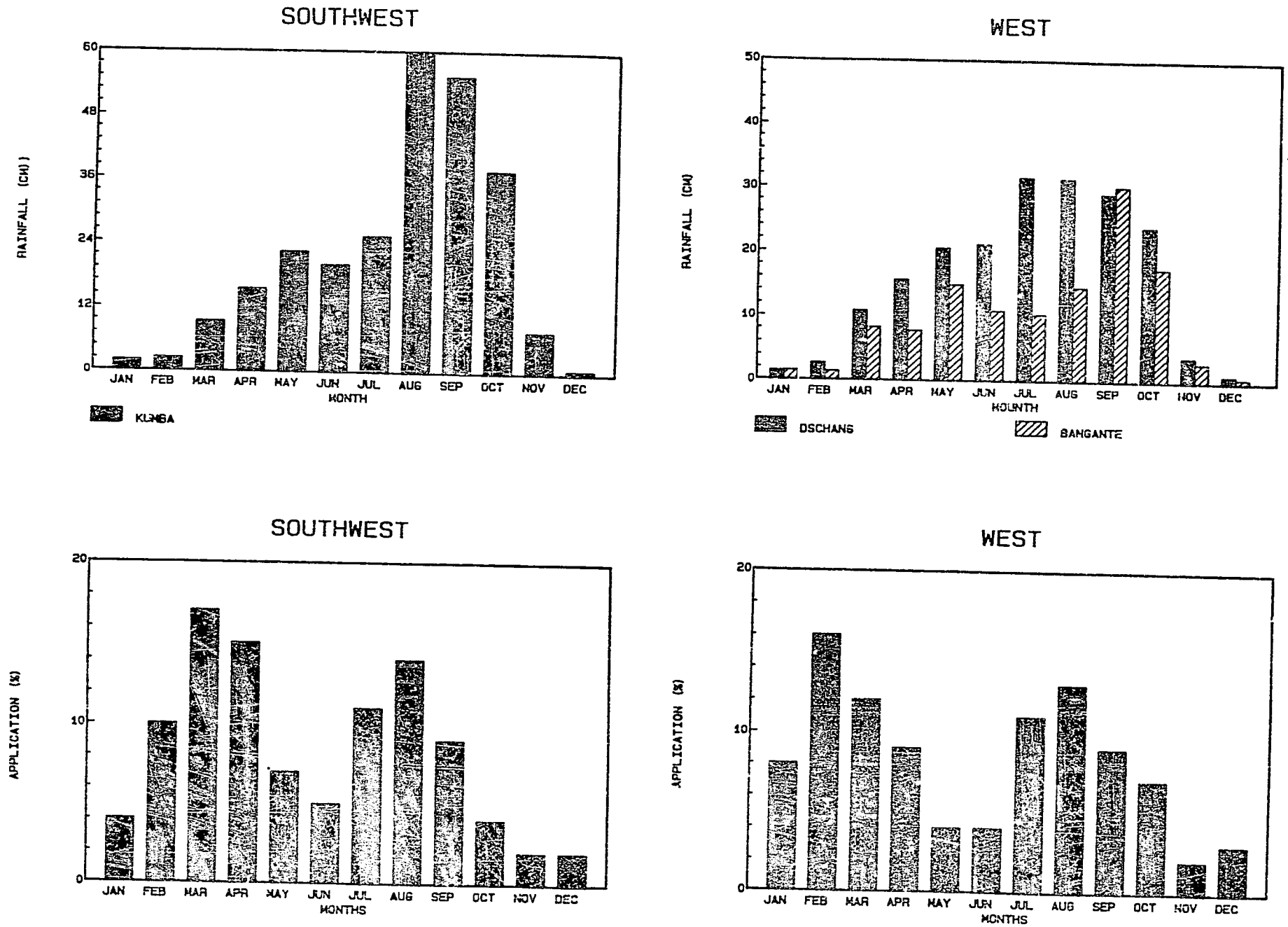


Figure . Rainfall Pattern and Fertilizer Application by Provinces in Cameroon (Continued).

APPENDIX K

Extent of Cameroon Road Network

Appendix K, Table 1. Extent of Road Network in Cameroon (Length System by Subdivision)

Subdivisions	Tarred Roads	Laterite			Rural Roads		Total
		National	Provincial	Departmental			
Extreme North							
Logone et Chari (Kousseri)	128	99	140	177	184	38	766
Mayo Sava (Mora)	84	35	22	124	43	0	308
Diamaré Maroua	129	-	143	199	169	165	805
Mayo Tsanaga (Mokolo)	45	-	192	131	49	40	457
Kaélé (Kaélé)	20	20	78	40	290	16	524
Mayo Danay (Yagoua)	0	53	146	264	110	106	679
Subtotal	406	267	721	935	845	365	3,539
North							
Mayo Louti (Guider)	219	-	91	36	104	43	493
Bénoué (Garoua)	261	-	102	365	0	0	728
Mayo Rey (Tcholliré)	98	325	-	640	77	48	1,188
Faro (Poli)	34	-	169	-	135	64	402
Subtotal	612	326	362	1,041	316	155	2,811
Adamaoua							
Faro et Déo (Tignère)	0	-	101	137	0	0	238
Vina (Ngaoundéré)	93	235	30	239	63	0	660
Mbéré (Meiganga)	132	110	-	159	60	50	511
Djerem (Tibati)	105	178	77	28	0	0	388
Mayo Banyo (Banyo)	0	186	67	-	88	80	421
Subtotal	380	709	275	563	211	130	2,218

(Continued)

Appendix K, Table 1. Extent of Road Network in Cameroon (Length System by Subdivision) (Continued)

Subdivisions	Tarred Roads	Laterite			Rural Roads		Total
		National	Provincial	Departmental			
Central							
Mbam (Bafia)	44	100	163	269	0	45	621
Mbam (Yoko)	0	324	-	197	105	0	626
Mefou-Mfoundi (Mfou)	153	89	146	327	267	306	1,288
Myon et So'o (Mbalmayo)	74	48	64	56	106	83	431
Nyong et Kellé (Eséka)	11	54	243	167	273	352	1,110
Lékié (Monatélé)	114	9	202	92	156	144	717
Haute Sanaga (Nanga-Eboko)	0	212	62	69	132	90	565
Subtotal	396	916	1,100	1,254	1,094	1,067	5,827
South							
Ocean (Kribi)	9	259	196	202	68	89	823
Ntem (Ebolowa)	3	178	63	325	64		
Ntem (Ambam)	0	135	-	214	180	269	1,431
Dja et Lobo (Sangmélima)	71	72	119	358	57		
Dja et Lobo (Djoum)	0	409	-	87	150	71	1,394
Subtotal	83	1,053	378	1,186	519	429	3,648

(Continued)

Appendix K, Table 1. Extent of Road Network in Cameroon (Length System by Subdivision) (Continued)

Subdivisions	Tarred Roads	Laterite			Rural Roads		Total
		National	Provincial	Departmental			
East							
Lom et Djerem (Bertoua)	22	253	-	160	0	41	476
Lom et Djerem (Bétaré-Oya)	12	154	161	-	150		477
Haut-Nyong (Abong-Mbang)	0	147	454	115	225	252	1,662
Haut-Nyong (Nguélémendouka)	0	51	115	125	125	178	
Kadey (Batouri)	0	205	136	404	83	68	896
Boumba-Nkogo (Yokadouma)	0	-	295	245	50	53	643
Subtotal	34	810	1,161	1,049	686	414	4,154
West							
Noun (Foumban)	30	66	92	62	180	213	1,129
Noun (Foumbot)	26	-	253	116	91	-	-
Bamboutos (Mbouda)	38	-	70	20	224	59	411
Mifi (Bafoussam)	98	18	7	106	206	78	504
Menoua (Dschang)	0	-	145	129	225	73	572
Haut-Nkam (Bafang)	49	-	87	135	156	46	473
Ndé (Bangangté)	0	60	38	79	121	115	413
Subtotal	232	144	692	647	1,203	584	3,502
Littoral							
Mungo (Nkongsamba)	190	-	46	42	198	196	672
Sanaga-Maritime (Edéa)	38	104	20	188	148	-	-
Sanaga-Maritime (Ndom)	0	-	78	197	260	81	1,114
Nkam (Yabassi)	31	-	327	-	39	30	427
Wouri (Douala)	107	-	-	25	0	-	132
Subtotal	366	104	471	452	645	307	2,345

(Continued)

Appendix K, Table 1. Extent of Road Network in Cameroon (Length System by Subdivision) (Continued)

Subdivisions	Tarred Roads	Laterite			Rural Roads		Total
		National	Provincial	Departmental			
South West							
Fako (Limbe)	166	-	13	66	178	135	558
Meme (Kumba)	186	70	67	165	341	233	1,062
Manyu (Mamfé)	43	173	65	75	146	289	791
Ndian (Mundemba)	0	70		110	99	50	329
Subtotal	395	313	145	416	764	707	2,740
North West							
Dong-Mantung (Nkambé)	4	76	67	147	70	75	439
Menchum (Wum)	4	101	90	49	109	184	617
Momo (Mbengwi)	0	56	22	117	290	113	598
Mezam (Bamenda)	56	163	65	25	183	155	647
Bui (Kumbo)	4	63	12	32	437	272	820
Subtotal	68	459	256	370	1,169	799	3,121
TOTAL	2,922	5,100	5,561	7,913	7,452	4,957	33,905

Source: Ministry of Equipment, Department of Highway, July 1984.

Appendix K, Table 2. Road Damage Effects of Various Truck Loadings

Type of Truck	Payload (tons)	Gross Vehicle Weight (gvw) (tons)	Axle Load (tons)					Road Damaging Effect	
			Tractor			Trailer		Equivalent Number of Standard Axles (of 8,200 kg) For 1 Pass[a]	Number of Standard Axles Per 100 Tons Payload Carried
			Steering	Drive Front	Drive Rear	Front	Rear		
4-axle articulated (14-wheel)	0 Empty	12	4.7	-	3.4	1.9	2.0	0.1	NA
	20	32	5.7	-	8.0	9.1	9.2	4.6	23
	25	37[b]	5.9	-	9.3	10.9[b]	10.9[b]	11.2	45
	30	42[b]	6.2	-	10.4[b]	12.7[b]	12.7[b]	17.7	59
	35	47[b]	6.4	-	11.6[b]	14.5[b]	14.5[b]	31.0	89
5-axle articulated (18-wheel)	0 Empty	13.4	4.9	1.9	3.1	2.7	1.8	0.1	NA
	20	33.4[b]	5.6	4.4	7.3	8.0	8.1	2.9	14
	25	38.4[b]	5.8	5.0	8.3	9.6	9.7	5.5	22
	30	43.4[b]	6.0	5.6	9.4	11.2[b]	11.2[b]	10.5	35
	35	43.4[b]	6.2	6.2	10.4[b]	12.8[b]	12.8[b]	18.7	53

a. Based on little equivalence factors as given in TRRL Road Note 31 (Section 4.2.3).
b. Exceeds statutory maximum.

Source: Data from Mercedes-Benz (U.K.), Ltd. and Consultants' estimates. Damaging effects will be similar for any other make of vehicle.

APPENDIX L

Fertilizer Law

UNIFORM STATE FERTILIZER BILL

NOTE—Although this Bill and Regulations have not been passed into law in all states, the subject matter covered herein does represent the official policy of this Association.

AN ACT to regulate the sale and distribution of commercial fertilizers in the State of . BE IT ENACTED BY the Legislature of the State of

Section 1. Title.

This Act shall be known as the " Fertilizer Law of 19 ."

Section 2. Enforcing Official.

This Act shall be administered by the of the State of , hereinafter referred to as the ."

Section 3. Definitions of Words and Terms.

When used in this Act:

(a) The term "commercial fertilizer" means any substance containing one or more recognized plant nutrient(s) which is used for its plant nutrient content and which is designed for use or claimed to have value in promoting plant growth, *except* unmanipulated animal and vegetable manures, marl, lime, limestone, wood ashes and gypsum, and other products exempted by regulation of the .

(1) A "fertilizer material" is a commercial fertilizer which either:

A. Contains important quantities of no more than one of the primary plant nutrients (nitrogen, phosphoric acid and potash), or

B. Has approximately 85% of its plant nutrient content present in the form of a single chemical compound, or

C. Is derived from a plant or animal residue or by-product or a natural material deposit which has been processed in such a way that its content of primary plant nutrients has not been materially changed except by purification and concentration.

(2) A "mixed fertilizer" is a commercial fertilizer containing any combination of mixture of fertilizer materials.

(3) A "specialty fertilizer" is a commercial fertilizer distributed primarily for nonfarm use, such as home gardens, lawns, shrubbery, flowers, golf courses, municipal parks, cemeteries, greenhouses and nurseries.

(4) A "bulk fertilizer" is a commercial fertilizer distributed in a non-packaged form.

(b) The term "brand" means a term, design, or trade mark used in connection with one or several grades of commercial fertilizer.

(c) Guaranteed Analysis:

(1) Until the prescribes the alternative form of "guaranteed analysis" in accordance with the provisions of subparagraph (2) hereof, the term "guaranteed analysis" shall mean the minimum percentage of plant nutrients claimed in the following order and form:

A. Total Nitrogen (N) per cent
Available Phosphoric Acid (P_2O_5) per cent
Soluble Potash (K_2O) per cent

B. For unacidulated mineral phosphatic materials and basic slag, bone, tankage and other organic phosphate materials, the total phosphoric acid and/or degree of fineness may also be guaranteed.

C. Guarantees for plant nutrients other than nitrogen, phosphorus and potassium may be permitted or required by regulation of the . The guarantees for such other nutrients shall be expressed in the form of the element. The sources of such other nutrients (oxides, salt, chelates, etc.) may be required to be stated on the application for registration and may be included as a parenthetical statement on the label. Other beneficial substances or compounds, determinable by laboratory methods, also may be guaranteed by permission of the and with the advice of the Director of the Agricultural Experiment Station. When any plant nutrients or other substances or compounds are guaranteed, they shall be subject to inspection and analysis in accord with the methods and regulations prescribed by .

D. Potential basicity or acidity expressed in terms of calcium carbonate equivalent in multiples of one hundred pounds per ton, when required by regulation.

(2) When the finds, after public hearing following due notice, that the requirement for expressing the guaranteed analysis of phosphorus and potassium in elemental form would not impose an economic hardship on distributors and users of fertilizer by reason of conflicting labeling requirements among the states, he may require by regulation thereafter that the "guaranteed analysis" shall be in the following form:

Total Nitrogen (N) ——— per cent
Available Phosphorus (P) ——— per cent
Soluble Potassium (K) ——— per cent

Provided, however, that the effective date of said regulation shall be not less than six months following the issuance thereof, and provided, further, that for a period two years following the effective date of said regulation the equivalent of phosphorus and potassium may also be shown in the form of phosphoric acid and potash; provided, however, that after the effective date of a regula-

tion issued under the provisions of this section, requiring that phosphorus and potassium be shown in the elemental form, the guaranteed analysis for nitrogen, phosphorus, and potassium shall constitute the grade.

(d) The term "grade" means the percentage of total nitrogen, available phosphorus or phosphoric acid, and soluble potassium or soluble potash stated in whole numbers in the same terms, order and percentages as in the guaranteed analysis. Provided however that fertilizer materials, bone meal, manures, and similar raw materials may be guaranteed in fractional units.

(e) The term "official sample" means any sample of commercial fertilizer taken by the or his agent and designated as "official" by the .

(f) The term "ton" means a net weight of two thousand pounds avoirdupois.

(g) The term "per cent" or "percentage" means the percentage by weight.

(h) The term "person" includes individual, partnership, association, firm, and corporation.

(i) The term "distributor" means any person who imports, consigns, manufactures, produces, compounds, mixes, or blends commercial fertilizer, or who offers for sale, sells, barters or otherwise supplies commercial fertilizer in this state.

(j) The term "registrant" means the person who registers commercial fertilizer under the provisions of this Act.

(k) The term "label" means the display of all written, printed or graphic matter upon the immediate container or statement accompanying a commercial fertilizer.

(l) The term "labeling" means all written, printed or graphic matter, upon or accompanying any commercial fertilizer, or advertisements, brochures, posters, television and radio announcements used in promoting the sale of such commercial fertilizers.

(m) The term "investigational allowance" means an allowance for variations inherent in the taking, preparation and analysis of an official sample of commercial fertilizer.

Section 4. Registration (Option A)

(a) Each brand and grade of commercial fertilizer shall be registered before being distributed in this State. The application for registration shall be submitted to the..... on a form furnished by the ....., and shall be accompanied by a fee of $.....per brand and grade except that those fertilizers sold in packages of 10 pounds or less shall be registered at a fee of twenty-five dollars each. Upon approval by the..... .....a copy of the registration shall be furnished to the applicant. All registrations expire on ... .of the following year.

The application shall include the following information:

(1) The net weight

(2) The brand and grade

(3) The guaranteed analysis

(4) The name and address of the registrant

(b) A distributor shall not be required to register any commercial fertilizer which is already registered under this Act by another person, providing the label does not differ in any respect.

(c) A distributor shall not be required to register each grade of commercial fertilizer formulated according to specifications which are furnished by a consumer prior to mixing, but shall be required to register his firm in a manner and at a fee as prescribed in the regulations by the , and to label such fertilizer as provided in Section 5 (b).

Licensing (Option B)

(a) No person shall manufacture or distribute in this state any type of fertilizer, except specialty fertilizers, until a license to distribute has been obtained by the person whose labeling is applied to such fertilizer from the .....upon payment of a $.....fee. All licenses expire on the thirtieth day of June of each year.

(b) An application for license shall include:

(1) The name and address of licensee;

(2) The name and address of each bulk distribution point in the state, not licensed for fertilizer manufacture and distribution.

The name and address shown on the license shall be shown on all labels, pertinent invoices, and bulk storage for fertilizers distributed by the licensee in this state.

(c) The licensee shall inform the.....in writing of additional distribution points established during the period of the license.

(d) No person shall distribute in this state a specialty fertilizer until it is registered by the manufacturer or distributor with the . An application in duplicate, for each brand and product name of each grade of specialty fertilizer shall be made on a form furnished by the .....and shall be accompanied with a fee of $.....for each brand and product name of each grade. Labels for each brand and product name of each grade shall accompany the application. Upon the approval of an application by the....., a copy of the registration shall be furnished the applicant. All registrations expire on the thirtieth day of June of each year.

(e) An application for registration shall include the following:
(1) Name and address of the manufacturer or distributor;
(2) The brand and product name;
(3) The grade;
(4) The guaranteed analysis;
(5) The package sizes for persons that package fertilizers only in containers of ten pounds or less.

Section 5. Labels

(a) Any commercial fertilizer distributed in this State in containers shall have placed on or affixed to the container a label setting forth in clearly legible and conspicuous form the information required by Section 4 (a) (1), (2), (3) and (4) of this Act. In case of bulk shipments, this information in written or printed form shall accompany delivery and be supplied to the purchaser at time of delivery.

(b) A commercial fertilizer formulated according to specifications which are furnished by a consumer prior to mixing shall be labeled to show the net weight, guaranteed analysis, and the name and address of the distributor.

Section 6. Inspection Fees.

(a) There shall be paid to the for all commercial fertilizers distributed in this State an inspection fee at the rate of cents per ton: Provided, that sales to manufacturers or exchanges between them are hereby exempted. Fees so collected shall be used for the payment of the costs of inspection, sampling, and analysis, and other expenses necessary for the administration of this Act.
On individual packages of commercial fertilizer containing 10 pounds or less, there shall be paid in lieu of the annual registration fee of per brand and grade and the ..... cents per ton inspection fee, an annual registration fee and inspection fee of twenty-five dollars for each brand and grade sold or distributed. Where a person sells commercial fertilizer in packages of 10 pounds or less and in packages over 10 pounds, this annual registration and inspection fee of twenty-five dollars shall apply only to that portion sold in packages of 10 pounds or less, and that portion sold in packages over 10 pounds shall be subject to the same inspection fee of cents per ton as provided in this Act.

(b) Every person who distributes a commercial fertilizer in this State shall:
File with the on forms fu...nished by ..... a quarterly statement for the periods ending September 30, December 31, March 31 and June 30, setting forth the number of net tons of each commercial fertilizer distributed in this state during such quarter. The report shall be due on or before the thirtieth day of the month following the close of each quarter and upon such statement shall pay the inspection fee at the rate stated in paragraph (a) of this section. If the tonnage report is not filed and the payment of inspection fee is not made within 30 days after the end of the quarter, a collection fee amounting to 10 percent (minimum $10.00) of the amount shall be assessed against the registrant, and the amount of fees due shall constitute a debt and become the basis of a judgment against the registrant.

(c) When more than one person is involved in the distribution of a commercial fertilizer, the last person who has the fertilizer registered and who distributes to a nonregistrant (dealer or consumer) is responsible for reporting the tonnage and paying the inspection fee, unless the report and payment is made by a prior distributor of a fertilizer.

Section 7. Tonnage Reports.

(a) The person transacting, distributing or selling commercial fertilizer to a nonregistrant shall mail the a report showing the county of the consignee, the amounts (tons) of each grade of commercial fertilizer, and the form in which the fertilizer was distributed (bags, bulk, liquid, etc.). This information shall be reported by *one* of the following methods: (1) submitting a summary report approved by the on or before the day of each month covering shipments made during the preceding month; or (2) submitting a copy of the invoice within business days after shipment. No information furnished the under this section shall be disclosed in such a way as to divulge the operation of any person.

Section 8. Inspection, Sampling, Analysis.

(a) It shall be the duty of the , who may act through his authorized agent, to sample, inspect, make analyses of, and test commercial fertilizers distributed within this State at any time and place and to such an extent he may deem necessary to determine whether such commercial fertilizers are in compliance with the provisions of this Act. The , individually or through his agent, is authorized to enter upon any public or private premises or carriers during regular business hours in order to have access to commercial fertilizers subject to the provisions of this Act and the rules and regulations pertaining thereto, and to the records relating to their distribution.

(b) The methods of analysis and sampling shall be those adopted by the from sources such as the A.O.A.C. Journal.

(c) The , in determining for administrative purposes whether any commercial fertilizer is deficient in plant food, shall be guided solely by the official sample as defined in paragraph (c) of Section 3, and obtained and analyzed as provided for in paragraph (b) of this section.

(d) The results of official analysis of commercial fertilizers and

portions of official samples shall be distributed by the ..... as provided in the regulations.

Section 9. Plant Food Deficiency.

(a) Penalty for Nitrogen, Available Phosphoric Acid or Phosphorus and Potash or Potassium—If the analysis shall show that a commercial fertilizer is deficient (1) in one or more of its guaranteed primary plant foods (NPK) beyond the "investigational allowances" as established by regulation, or (2) if the overall index value of the fertilizer is below the level established by regulations, a penalty of times the commercial value of such deficiency or deficiencies shall be assessed. When a commercial fertilizer is subject to a penalty under both (1) and (2) the larger penalty shall apply.

(b) Penalty for Other Deficiencies — Deficiencies beyond the investigational allowances as established by regulation in any other constituent(s) covered under Section 3 paragraph (c) B, C, and D of this Act, which the registrant is required to or may guarantee, shall be evaluated and penalties prescribed therefore by the.....

(c) Nothing contained in this section shall prevent any person from appealing to a court of competent jurisdiction praying for judgment as to the justification of such penalties.

(d) All penalties assessed under this section shall be paid to the consumer of the lot of commercial fertilizer represented by the sample analyzed within three months after the date of notice from the to the registrant, receipts taken therefor and promptly forwarded to the . If said consumers cannot be found, the amount of the penalty shall be paid to the who shall deposit the same (or shall pay said penalty to some local charitable or educational institution.)

Section 10. Commercial Value.

For the purpose of determining the commercial value to be applied under the provisions of Section 9 the shall determine and publish annually the values per unit of nitrogen, available phosphoric acid, and soluble potash in commercial fertilizers in this state. If guarantees are as provided in Section 3 (c) (2) the value shall be per unit of nitrogen, phosphorus, and potassium. The values so determined and published shall be used in determining and assessing penalties.

Section 11. Misbranding.

No person shall distribute misbranded fertilizer. A commercial fertilizer shall be deemed to be misbranded:

(a) If its labeling is false or misleading in any particular.

(b) If it is distributed under the name of another fertilizer product.

(c) If it is not labeled as required in Section 5 of this act and in accordance with regulations prescribed under this act.

(d) If it purports to be or is represented as a commercial fertilizer, or is represented as containing a plant nutrient or commercial fertilizer unless such plant nutrient or commercial fertilizer conforms to the definition of identity, if any, prescribed by regulation of the ; in the adopting of such regulations the shall give due regard to commonly accepted definitions and official fertilizer terms such as those issued by the Association of American Plant Food Control Officials.

Section 12. Adulteration.

No person shall distribute an adulterated fertilizer product. A commercial fertilizer shall be deemed to be adulterated:

(a) If it contains any deleterious or harmful ingredient in sufficient amount to render it injurious to beneficial plant life when applied in accordance with directions for use on the label, or if adequate warning statements or directions for use, which may be necessary to protect plant life are not shown upon the label.

(b) If its composition falls below or differs from that which it is purported to possess by its labeling.

(c) If it contains unwanted crop seed or weed seed.

Section 13. Publications.

The shall publish at least annually and in such forms as he may deem proper: (a) Information concerning the distribution of commercial fertilizers, (b) Results of analyses based on official samples of commercial fertilizers distributed within the state as compared with the analyses guaranteed under Section 4 and Section 5.

Section 14. Rules and Regulations.

The is authorized to prescribe and, after a public hearing following due public notice, to enforce such rules and regulations relating to investigational allowances, definitions, records, and the distribution of commercial fertilizers as may be necessary to carry into effect the full intent and meaning of this Act.

Section 15. Short Weight.

If any commercial fertilizer in the possession of the consumer is found by the to be short in weight, the registrant of said commercial fertilizer shall within thirty days after official notice from the pay to the consumer a penalty equal to four times the value of the actual shortage.

Section 16. Cancellation of Registrations.

The is authorized and empowered to cancel the registration of any brand of commercial fertilizer or to refuse to register any brand of commercial fertilizer as herein provided, upon satisfactory evidence that the registrant has used fraudulent or deceptive practices in the evasions or attempted

evasions of the provisions of this Act or any rules and regulations promulgated thereunder: Provided, that no registration shall be revoked or refused until the registrant shall have been given the opportunity to appear for a hearing by the .

Section 17. "Stop Sale" Orders.

The may issue and enforce a written or printed "stop sale, use, or removal" order to the owner or custodian of any lot of commercial fertilizer and to hold at a designated place when the finds said commercial fertilizer is being offered or exposed for sale in violation of any of the provisions of this Act until the law has been complied with and said commercial fertilizer is released in writing by the , or said violation has been otherwise legally disposed of by written authority. The shall release the commercial fertilizer so withdrawn when the requirements of the provisions of this Act have been complied with and all costs and expenses incurred in connection with the withdrawal have been paid.

Section 18. Seizure, Condemnation, and Sale.

Any lot of commercial fertilizer not in compliance with the provisions of this Act shall be subject to seizure on complaint of the to a court of competent jurisdiction in the area in which said commercial fertilizer is located. In the event the court finds the said commercial fertilizer to be in violation of this Act and orders the condemnation of said commercial fertilizer it shall be disposed of in any manner consistent with the quality of the commercial fertilizer and the laws of the State: Provided, that in no instance shall the disposition of said commercial fertilizer be ordered by the court without first giving the claimant an opportunity to apply to the court for release of said commercial fertilizer or for permission to process or relabel said commercial fertilizer to bring it into compliance with this Act.

Section 19. Violations.

(a) If it shall appear from the examination of any commercial fertilizer that any of the provisions of this Act or the rules and regulations issued thereunder have been violated, the shall cause notice of the violations to be given to the registrant, distributor, or possessor from whom said sample was taken; any person so notified shall be given opportunity to be heard under such rules and regulations as may be prescribed by the . If it appears after such hearing, either in the presence or absence of the person so notified, that any of the provisions of this Act or rules and regulations issued thereunder have been violated, the may certify the facts to the proper prosecuting attorney.

(b) Any person convicted of violating any provision of this Act or the rules and regulations issued thereunder shall be punished in the discretion of the court.

(c) Nothing in this Act shall be construed as requiring the or his representative to report for prosecution or for the institution of seizure proceedings as a result of minor violations of the Act when he believes that the public interests will be best served by a suitable notice of warning in writing.

(d) It shall be the duty of each attorney to whom any violation is reported to cause appropriate proceedings to be instituted and prosecuted in a court of competent jurisdiction without delay.

(e) The is hereby authorized to apply for and the court to grant a temporary or permanent injunction restraining any person from violating or continuing to violate any of the provisions of this Act or any rule or regulation promulgated under the Act notwithstanding the existence of other remedies at law. Said injunction to be issued without bond.

Section 20. Exchanges between Manufacturers.

Nothing in this Act shall be construed to restrict or avoid sales or exchanges of commercial fertilizers to each other by importers, manufacturers, or manipulators who mix fertilizer materials for sale or as preventing the free and unrestricted shipments of commercial fertilizer to manufacturers or manipulators who have registered their brands as required by the provisions of this Act.

Section 21. Constitutionality.

If any clause, sentence, paragraph or part of this Act shall for any reason be judged invalid by any court of competent jurisdiction, such judgment shall not affect, impair, or invalidate the remainder thereof but shall be confined in its operation to the clause, sentence, paragraph, or part thereof directly involved in the controversy in which such judgment shall have been rendered.

Section 22. Repeal.

All laws and parts of laws in conflict with or inconsistent with the provisions of this Act are hereby repealed.

Section 23. Effective Date.

This Act shall take effect and be in force from and after the first day of .

RULES AND REGULATIONS

Under the Uniform State Fertilizer Bill by the of the State of .

Pursuant to due publication and notice of opportunity for a public hearing, the has adopted the following regulations.

1. Plant Nutrients in addition to Nitrogen, Phosphorus and Potassium

Other Plant Nutrients, when mentioned in any form or manner shall be registered and shall be guaranteed. Guarantees shall be made on the elemental basis. Sources of the elements guaranteed and proof of availability shall be provided the upon request. The minimum percentages which will be accepted for registration are as follows:

Element	%
Calcium (Ca)	1.00
Magnesium (Mg)	0.50
Sulfur (S)	1.00
Boron (B)	0.02
Chlorine (Cl)	0.10
Cobalt (Co)	0.0005
Copper (Cu)	0.05
Iron (Fe)	0.10
Manganese (Mn)	0.05
Molybdenum (Mo)	0.0005
Sodium (Na)	0.10
Zinc (Zn)	0.05

Guarantees or claims for the above listed plant nutrients are the only ones which will be accepted. Proposed labels and directions for use of the fertilizer shall be furnished with the application for registration upon request. Any of the above listed elements which are guaranteed shall appear in the order listed immediately following guarantees for the primary nutrients of nitrogen, phosphorus and potassium.

A warning or caution statement is required on the label for any product which contains 0.03% or more of boron in a water soluble form. This statement shall carry the word "WARNING" or "CAUTION" conspicuously displayed, shall state the crop(s) for which the fertilizer is to be used, and state that the use of the fertilizer on any other than those recommended may result in serious injury to the crop(s).

Products containing 0.001% or more of molybdenum also require a warning statement on the label. This shall include the word "WARNING" or "CAUTION" and the statement that the application of fertilizers containing molybdenum may result in forage crops containing levels of molybdenum which are toxic to ruminant animals.

EXAMPLES OF WARNING OR CAUTION STATEMENTS:

Boron:

1. Directions: Apply this fertilizer at a maximum rate of 350 pounds per acre for Alfalfa or Red Clover seed production. CAUTION: Do not use on other crops. The boron may cause injury to them.
2. CAUTION: Apply this fertilizer at a maximum rate of 700 pounds per acre for Alfalfa or Red Clover seed production. Do not use on other crops; the boron may cause serious injury to them.
3. WARNING: This fertilizer carries added Borax and is intended for use only on alfalfa. Its use on any other crops or under conditions other than those recommended may result in serious injury to the crops.

Molybdenum:

1. CAUTION: This fertilizer is to be used only on soil which responds to molybdenum. Crops high in molybdenum are toxic to grazing animals (ruminants).

2. Specialty Fertilizer Labels

The following information, if not appearing on the face or display side in a *readable and conspicuous form*, shall occupy at least the upper-third of a side of the container and shall be considered the label.

(a) Net Weight
(b) Brand and Grade
(c) Guaranteed Analysis:
Total Nitrogen (N) _____%
_____% Ammoniacal Nitrogen**
_____% Nitrate Nitrogen**
_____% Water Insoluble Nitrogen*
Available Phosphoric Acid (P_2O_5) _____%
Soluble Potash (K_2O) _____%
Additional Plant Nutrients as prescribed by regulation.
**Potential Acidity or Basicity_____% or_____lbs. Calcium Carbonate Equivalent per ton.
(d) Name and address of registrant

Notes:
*If claimed or the statement "organic" or "slow acting nitrogen" is used on the label
**If claimed or required

3. Slowly Available Plant Nutrients
(a) No fertilizer label shall bear a statement that connotes or infers the presence of a slowly available plant nutrient, unless the nutrient or nutrients are identified.
(b) When a fertilizer label infers or connotes that the nitrogen is slowly available through use of organic, organic nitrogen, ureaform, long lasting or similar terms, the guaranteed analysis must indicate the percentage of water insoluble nitrogen in the material.

(c) To supplement (b), it should be established that if a label states the amount of organic nitrogen present in a phrase, such as "25% of the nitrogen from ureaformaldehyde (ureaform)," then the water insoluble nitrogen guarantee must be not less than 60% of the nitrogen so designated.

Example: 10-6-4 Rose Food
25% of Nitrogen is Organic
10(Total N Guaranteed) x .25(% N Claimed as (Organic) x .60 = 1.5% WIN

(d) When the water insoluble nitrogen is less than 15% of the total nitrogen, the label shall bear no references to any designations, such as stated in (b).

(e) The term "Coated-Slow Release Fertilizer," or "Coated-Slow Release" may be accepted as descriptive of products.

(f) Further, the above phrases (e) be allowed for any products that can show a testing program substantiating the claim. (Testing under guidance of Experiment Station personnel, or a recognized reputable researcher, etc.) Water insoluble nitrogen must be guaranteed at the 15% of total nitrogen level as in organic materials.

(g) That AOAC method 2.072 be used initially to substantiate the fact that "Coated-Slow Release" materials are present. The determination need only be modified by elimination of sample grind-ind during preparation. When the AOAC Committee, working on this problem, comes up with a more specific method it will, of course, be substituted.

4. Definitions

Except as the designates otherwise in specific cases, the names and definitions for commercial fertilizers shall be those adopted by the Association of American Plant Food Control Officials.

5. Percentages

The term of "percentage," by symbol or word, when used on a fertilizer label shall represent only the amount of individual plant nutrients or other factors in relation to the total product by weight.

6. Investigational Allowances

(a) A commercial fertilizer shall be deemed deficient if the analysis of any nutrient is below the guarantee by an amount exceeding the values in the following schedule, or if the overall index value of the fertilizer is below 98%.*

Guarantee percent	Nitrogen percent	Available Phosphoric acid percent	Potash percent
4 or less	0.49	0.67	0.41
5	0.51	0.67	0.43
6	0.52	0.67	0.47
7	0.54	0.68	0.53
8	0.55	0.63	0.60
9	0.57	0.68	0.65
10	0.58	0.69	0.70
12	0.61	0.69	0.79
14	0.63	0.70	0.87
16	0.67	0.70	0.94
18	0.70	0.71	1.01
20	0.72	0.72	1.08
22	0.75	0.72	1.15
24	0.78	0.73	1.21
26	0.81	0.73	1.27
28	0.83	0.74	1.33
30	0.86	0.75	1.39
32 or more	0.88	0.76	1.44

For guarantees not listed, calculate the appropriate value by interpolation.

*For these investigational allowances to be applicable, the recommended AOAC procedures for obtaining samples, sample preparation and analysis must be used. These are described in Official Methods of Analysis of the Association of Official Analytical Chemists, 11th edition, 1970, and in succeeding issues of the Journal of the Association of Official Analytical Chemists. In evaluating replicate data, table 19, page 935, Journal of the Association of Official Analytical Chemists, volume 49, No. 5, October, 1966 should be followed.

Averaging at least two values must be adhered to. If more than two values are obtained, all significant values must be averaged. Values carried to two decimals are needed in applying averages to this table. Values may be "rounded" to one place where preferred in reporting. The overall index value is calculated by comparing the commercial value guaranteed with the commercial value found. Unit values of the nutrients used shall be those referred to in Section 10.

Overall index value—example of calculation for a 10-10-10 grade found to contain 10.1% Total Nitrogen (N), 10.2% Available Phosphoric Acid (P_2O_5), and 10.1% Soluble Potash (K_2O). Nutrient unit values are assumed to be $3 per unit N, $2 per unit P_2O_5, and $1 per unit K_2O.

10.0 units N	x 3 =	30.0
10.0 units P_2O_5	x 2 =	20.0
10.0 units K_2O	x 1 =	10.0
Commercial Value Guarantee	=	60.0
10.1 units N	x 3 =	30.3
10.2 units P_2O_5	x 2 =	20.4
10.1 units K_2O	x 1 =	10.1
Commercial Value Found	=	60.8

$$\text{Overall index value} = \frac{60.8}{60.0} \times 100 = 101.3\%$$

(b) Secondary and minor elements shall be deemed deficient if any element is below the guarantee by an amount exceeding the values in the following schedule:

Element	Allowable Deficiency
Calcium Magnesium Sulfur	0.2 unit + 5% of guarantee " " " " " "
Boron	0.003 unit + 15% of guarantee
Cobalt Molybdenum	0.0001 unit + 30% of guarantee " " "
Chlorine Copper Iron Manganese Sodium Zinc	0.005 unit + 10% of guarantee " " " " " " " " " " " " " " "

The maximum allowance when calculated in accordance to the above shall be 1 unit (1%).

7. Sampling

Sampling equipment and procedures shall be those adopted by The Association of Official Analytical Chemists wherever applicable.

APPENDIX M

Premises and Assumptions Used for Preparing Capital Investment and Production Cost Estimates

APPENDIX M

PREMISES AND ASSUMPTIONS USED FOR PREPARING CAPITAL INVESTMENT AND PRODUCTION COST ESTIMATES

1. Cost estimates are on a 1985 U.S. dollar basis.
2. Capital investment estimates do not include allowances for land and infrastructure outside the plant site boundary such as ports, roads, gas wells, and pipeline facilities.
3. The capital investment estimates for the battery limits process units, raw materials, product storage and handling facilities, and auxiliary and support facilities within the plant site are based on turnkey-type contracts.
4. Working capital estimates include allowances for raw materials and intermediate and finished product inventories, spare parts, and cash (or contingency).
5. The base-case price for natural gas used for the production of ammonia is US \$6.0/million kcal (US \$1.5/million Btu). The price of imported wet-process phosphoric acid (54% P_2O_5) used for the production of DAP or MAP is US \$270/mt which is equivalent to US \$500/mt P_2O_5. The delivered price of phosphoric acid is based on an f.o.b. price of US \$140/mt of 54% P_2O_5 acid plus US \$100/mt for ocean freight and US \$30/mt for unloading, handling, and other changes.
6. Salaries, including wages and employee benefits for operations and maintenance personnel, are based on similar fertilizer plants and operations in the developing world.
7. The cost of administration and general overhead is based on 150% of personnel costs in the ammonia/urea/DAP complexes and 200% of the personnel costs in the bulk blending/bagging plants.
8. The cost of maintenance materials is based on 3% of total installed cost.
9. The cost of insurance is based on 1% of total installed cost.
10. The capital recovery factor is equivalent to 17.1% of total fixed investment. This factor corresponds to a plant life of 15 years and 15% annual interest and/or return on capital.

11. Annual interest on working capital is 13%.
12. The plant construction is assumed to be 1 year for the bulk blending/bagging plant, 2.5 years for the small ammonia/urea/DAP complex, and 4 years for the large ammonia/urea/DAP complex.

APPENDIX N

Scope of Work

APPENDIX N

SCOPE OF WORK

A. Fertilizer Use

1. Prepare an overview of fertilizer sector:
   a. Importance of the agriculture economy.
   b. Importance of fertilizer in crop production.
   c. Importance of fertilizer in national economy.
2. Select the most appropriate fertilizers:
   a. Review the relevant research on fertilizer use for principal crops as related to nutrient requirements, status of nutrient-supplying capacity of major soil types, response curves of applied nutrients, cropping systems relating to crop sequence, plant population and methods of applying nutrients, and application of economic values to nutrient requirements.
   b. Identify those products which are agronomically and economically most appropriate.
   c. Identify additional fertilizer use research required to continually improve and adjust fertilizer selection.
3. Estimate fertilizer demand:
   a. Gather and analyze statistical data on fertilizer imports, production, sales, and crop hectarage to estimate actual fertilizer consumption by nutrient, product, and geographic regions for the past 5 years in Cameroon.
   b. Forecast the fertilizer demand by nutrient product and by principal crops and geographic regions for the next 10 years (1986-96). Crop census data and fertilizer demand projections from other sources will be collected, reviewed, and analyzed.
   c. Discuss and present the method of forecasting.
4. Estimate the economics of fertilizer use:
   a. Utilizing existing data, establish farmer benefit to cost ratios for fertilizer use on principal crops at recommended rates.
   b. Utilizing crop response curves, estimate grower profit per hectare for crops using current prices.

562

c. Determine the cost of the fertilizers used in the present subsidized program.

B. Fertilizer Supply

1. Prepare a preliminary production and economic evaluation of two manufacturing schemes:

   a. Bulk-blending and bagging plant using imported bulk fertilizers.

   b. Ammonia, urea, and diammonium phosphate complex using Cameroon natural gas reserves and imported phosphoric acid. Urea will be in granular form as it is better suited for bulk-blend NPK fertilizer.

The capacity of the bulk-blending/bagging plant will be based on the fertilizer demand projection (see items 3a and 3b above). The capacities of the ammonia plant to be considered are: 200 and 1,000 metric tons per day (mtpd). All ammonia output will be used to produce urea and diammonium phosphate. The 200-mtpd ammonia plant would be for domestic consumption only. The other case would assume that capacity above domestic needs be exported. However, no analysis of export market will be included in this study. The capacities of the urea and diammonium phosphate plants will be recommended after discussions with the Cameroon Government on the relative distribution of these two products between the domestic and export markets.

The preliminary production economics of the two above production schemes will cover the following specific activities:

1. Select plant location taking into account land availability, existing support facility, handling and transportation of raw materials, finished products, and other relevant factors.
2. Describe process plant(s) and determine plant facility requirements.
3. Prepare preliminary fixed capital and working capital estimates. Cost estimates will cover only the process plants and direct support facilities such as raw materials, product storage and handling, utilities facilities, office buildings, and other necessary infrastructure within the plant site boundary. Cost estimates for infrastructure such as ports, roads, housing, warehouses, etc., outside the plant site will not be prepared. For the ammonia, urea, and diammonium phosphate production scheme,

the delivered cost of natural gas will be supplied by the Cameroon Government. If the natural gas price is not available, the consultants will estimate urea and diammonium phosphate production costs at different natural gas prices. In any case, no cost estimates for the gas wells and pipeline facilities will be made. Those costs are assumed to be charged to the delivered natural gas price.

4. Compare production costs of bulk-blended NPK product versus imported granular NPK and urea and diammonium phosphate production costs versus world market urea and diammonium phosphate prices to assess the potential product viability.
5. Prepare conclusions and make recommendations for each production scheme.

C. Fertilizer Marketing and Distribution

1. Review and update fertilizer costs of products as determined in prior studies to the farmers in principal provinces according to:
   a. c.i.f. Douala.
   b. Port charges.
   c. Warehousing costs.
   d. Transportation costs.
   e. Material losses.
   f. Working capital cost.
   g. Direct retailing cost.
   h. Other costs.
2. Estimate the total cost by product and nutrient, identify excessive cost, and recommend cost reduction procedures.
3. Evaluate present fertilizer marketing and distribution systems. Identify constraints and recommend procedures to overcome these constraints.
   a. Outline and evaluate the present tendering and procurement system.
   b. Determine the present flow channels for orders, products, title, payment, and information.
   c. Review and evaluate current storage and warehousing requirements.
   d. Evaluate present transportation channels used.
   e. Evaluate the effectiveness of the current extension service as related to fertilizer recommendation and use.

f. Determine the dealer/marketing organization(s) required to make fertilizers available on a timely basis to farmers within a practical distance in all provinces.

g. Evaluate personnel requirements to manage the present marketing system.

h. Make recommendations to overcome constraints to fertilizer use resulting from the present marketing system.

4. Identify additional infrastructure and government policy required to support a successful fertilizer marketing system:

a. Evaluate the present road network and specify the need for adequate roads in increasing crop production.

b. Assess the availability of other essential crop production inputs.

c. Evaluate the availability of structured markets for farmers to sell their crop produce.

d. Identify formal training and personnel development required to manage a fertilizer marketing system.

e. Make recommendations for the infrastructure and additional government policy and actions required to support an effective fertilizer marketing system.