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Politiques des Engrais en Afrique Tropicale

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Welcome and Opening Remarks

Paul L.G. Vlek

Honored Guests:

It is my distinct pleasure to welcome you on behalf of Dr. McCune, Managing Director of IFDC, and Dr. Mellor, Director of IFPRI, to the first workshop on "Fertilizer Policy Research in sub-Saharan Africa." We are extremely pleased that such an illustrious group of policymakers and analysts were prepared to set aside time to stand by the cradle of this important research initiative and share some of their accumulated wisdom with the young parents.

IFDC-Africa is a regional subcenter of IFDC, a non-profit international research and development organization with headquarters in the United States. IFDC seeks to study and eliminate constraints to fertilizer use in the developing world through research, training, and technical assistance. Today the Center is in its 14th year of operation and is equipped with state-of-the-art research facilities and a highly competent staff representing over 20 nationalities and a broad range of experience. IFDC has been an active collaborator with many countries in Asia, Africa, and Latin America.

IFDC-Africa was conceived several years ago when IFDC realized that a greater effort was necessary to develop the fertilizer sector in this part of the world in order to overcome food shortages and rural poverty. We recognize the need for research and training in all aspects of fertilizers with due recognition of the uniqueness of the African environments. IFDC recognizes that it can only be successful in its quest if it works hand in hand with the considerable expertise lodged in the national programs of the continent. In the Policy Research Program, IFDC joined hands with IFPRI, an international institute based in Washington, D.C., and widely recognized for its excellent work in the area of food policy research.

The rationale for initiating the program is relatively simple. The role that fertilizers play in the agricultural production systems of sub-Saharan Africa is extremely limited. Yet, with a steady decline in per capita food production in the region, and the increasing pressure on the fragile African environments, it is clear that some form of nutrient restitution will have to take the place of the declining fallows if soil fertility is to be maintained. In fact, today's soil fertility levels are widely regarded as inadequate to produce tomorrow's food needs; thus, the soils of the region require an infusion of nutrients beyond what is locally available. The notion that fertilizers will play a major role in filling this need is inescapable. As was the case in Asia during the sixties, more and more African governments are recognizing this hard fact. As a result, many African agricultural policies that are being formulated today set aside a major role for the fertilizer sector.

The fertilizer sector in sub-Saharan Africa ranks among the weakest in the world. Ample statistics will be given to you during this workshop to illustrate this fact. Yet, although the recognition of the importance of fertilizers is an important first step, the emergence of a fertilizer sector that will adequately serve that need is far from automatic. Fertilizers are specialty chemicals, relatively expensive yet with low profit margins, bulky, and difficult to store and handle. To incorporate them into agricultural systems that are largely subsistence-oriented, with poorly organized marketing, distribution, and credit systems, will require a political commitment and the establishment of favorable policies by the governments. In this context, it should be recognized that such policies and measures will affect not only the agricultural sector but also the financial and transportation sectors and possibly the mining and industrial sectors of the country. The complexity of the fertilizer sector is often not fully appreciated by the governments. However, ways are often found to bring about change through the development of the fertilizer sector. Asia is an example of what is possible.

The IFDC/IFPRI program was developed to help study the fertilizer situation in sub-Saharan Africa, to analyze the policies that affect fertilizer use, and to formulate policy recommendations that will stimulate the development of a viable fertilizer sector. Prioritizing the issues to be considered in this program will be the principal aim of the current workshop. However, we hope that your involvement in this program will not end when you return to your respective countries. We hope that the discussions over the next few days will identify particular topics that your countries are interested in studying. If so, these topics may be developed into research projects to be undertaken jointly between the IFDC/IFPRI team and a group of national policy analysts. We count on your knowledge of the in-country expertise to help identify qualified collaborators.

Fertilizer use is the result of a chain of events starting with the production or import of the product and ending with adoption at the farm level. Favorable policies

established in one link of the chain may be negated by other links that constrain the adoption of fertilizers by the farmers. It is therefore imperative that the principal constraints be properly identified and policy measures properly balanced. To a great extent, the necessary analysis of the fertilizer situation in Africa is lacking, in part due to an absence of adequate data. The lack of data often frustrates the design of a fertilizer strategy. IFDC-Africa, therefore, expects to assist in the collection of the required data through programs such as the Policy Research Project. Parallel efforts are underway to collect data in the following areas:

Fertilizer marketing and distribution
Fertilizer raw materials and processing
Fertilizer use and management
Fertilizer use and adoption

Although these different projects are of vital importance to our efforts, IFDC-Africa recognizes that no amount of data can substitute for a proper set of policies adopted by a government. It is for this reason that the Policy Research Program is considered the keystone of our research effort. Your assistance in this first phase is highly appreciated.

It is my pleasure to introduce to you the team of experts that IFDC and IFPRI are bringing to the region to support this effort. From IFPRI we have Dr. Tshikala Tshibaka, who is coordinating this effort, and his colleagues Drs. Ahmed, Desai, Jha, and Savant. From IFDC we have the collaboration of Mr. Coster, based in Togo, and Dr. Baanante and Dr. Bumb from Headquarters. Soon, we hope to appoint the principal scientist in this project who will be posted here in Lomé. This group of economists will provide a solid base for this program.

Before ending, I would like to express our sincere gratitude to the Government of Togo, our host country, for the hospitality it continues to extend towards IFDC in general, and to the participants of our workshop in particular. I hope that when you are ready to return to your respective homes you will leave with the same warm feelings towards this country that we at IFDC have developed during our residence here.

Next, I would like to recognize the donor for this important endeavor, the United States Agency for International Development (USAID). Several USAID representatives are participating in this workshop, which demonstrates the importance it attaches to the area of research that is addressed here. The workshop is an integral part of a Research Project funded by USAID for an initial period of five years and executed jointly by IFDC and IFPRI. We look forward to the continued involvement of the Agency in this endeavor and hope that the results will prove of value to their efforts in providing developmental assistance to the region.

Thus, on behalf of the directors of IFDC and IFPRI, I hereby declare the workshop open, and wish you success in your deliberations.

Thank you.

Mots De Bienvenue

Paul L.G. Vlek

Invités d'honneur:

C'est avec un grand plaisir que je vous souhaite la bienvenue au nom de M. McCune, Directeur Général de IFDC, et de M. Mellor, Directeur de l'IFPRI, à la première conférence de travail sur "la Politique de Recherche sur les Engrais en Afrique subsaharienne". Nous sommes très heureux qu'un groupe aussi distingué de décideurs et d'analystes puisse avoir pris le temps de participer à la naissance d'une initiative de recherche aussi importante et de partager la sagesse qu'ils ont accumulée avec les jeunes organisateurs.

L'IFDC-Afrique est un centre régional de l'IFDC, une organisation internationale de recherche et de développement à but non lucratif, siégeant aux USA. L'IFDC cherche à étudier et à éliminer les contraintes à l'utilisation des engrais dans les pays en développement à travers la recherche, la formation et l'assistance technique. Aujourd'hui, le centre est dans sa 14ème année de fonctionnement et est équipé avec les moyens de recherche les plus modernes et un personnel hautement compétent, représentant plus de 20 nationalités et une grande expérience. L'IFDC a été un collaborateur actif avec plusieurs pays d'Asie, d'Afrique, et d'Amérique Latine.

L'IFDC-Afrique a été conçue plusieurs années auparavant, lors de la constatation par l'IFDC qu'un plus grand effort était necéssaire pour développer le secteur des engrais dans cette partie du monde afin d'éliminer les pénuries de nourriture et la pauvreté rurale. Nous reconnaissons l'existence du besoin de recherche et de formation dans tous les aspects des engrais avec la prise en compte du caractère particulier des environnements africains. L'IFDC réalise qu'il ne réussira dans sa mission que s'il coopère étroitement avec les programmes nationaux du continent et leur expertise considérable accumulée dans le domaine. Dans le Programme de la Politique de Recherche, l'IFDC a collaboré avec l'IFPRI, un autre institut international, siégeant à Washington, D.C., et d'une renommée mondiale pour son excellent travail dans le domaine des politiques de recherche alimentaire.

La raison pour l'institution du programme est relativement simple. Le rôle que les engrais jouent dans la production agricole de l'Afrique subsaharienne est extrêmement limité. Cependant, avec une réduction constante de la production alimentaire par habitant dans la région, et la surexploitation des environnements africains qui sont plutôt fragiles, il est évident qu'une forme de restitution nutritive des sols doit remplacer la diminution des jachères si la fertilité des terres doit être maintenue. En fait, le niveau actuel de la fertilité des sols est considéré comme inadequat pour satisfaire les besoins alimentaires futures, et requiert donc, une infusion d'éléments nutritifs au delà des possibilités locales. La notion selon laquelle les engrais auront un rôle majeur dans la satisfaction de ce besoin est donc inéluctable. Comme c'était le cas de l'Asie durant les années soixante, de plus en plus de gouvernements africains prennent conscience de cette réalité brutale. Par conséquent, aujourd'hui, la formulation de plusieurs politiques agricoles africaines réserve un rôle majeur au secteur des engrais.

Le secteur des engrais en Afrique subsaharienne est l'un des plus faibles dans le monde. Plusieurs statistiques vous seront fournies durant cette conférence de travail pour illustrer ce point. Donc, bien que la prise conscience de l'importance des engrais est une importante première étape, l'émergence d'un secteur des engrais capable de satisfaire ce besoin d'une manière adéquate est loin d'être automatique. Les engrais sont des produits chimiques spéciaux, qui sont relativement chers mais avec des marges de profit faibles. Ils sont volumineux et difficiles à stocker et à manipuler. Un engagement politique et l'établissement de politiques favorables par les gouvernements sont nécessaires pour qu'ils soient utilisés par des systèmes agricoles largement à vocation de subsistance, et encadrés par des systèmes de commercialisation, distribution et de crédit qui sont très mal organisés. Dans ce contexte, il est bon de reconnaître que ces politiques et mesures auront un effet non seulement sur le secteur agricole mais aussi sur les secteurs financier et des transports, et probablement sur les secteurs minier et industriel. La réalité montre que la complexité du secteur des engrais n'est souvent pas appréciée par les gouvernements actuels, pour amorcer le changement à travers son développement. L'Asie en est un exemple.

Le programme IFDC/IFPRI a été mis en place afin d'étudier la situation des engrais en Afrique subsaharienne, d'analyser les politiques qui ont un effet sur leur utilisation, et de formuler des recommandations pratiques pour la stimulation du développement viable d'un secteur des engrais. Le but principal de cette conférence de travail est l'établissement de priorités entre ces aspects divers. Cependant, nous espérons que votre participation à ce programme ne finira pas avec votre retour dans vos pays respectifs. Nous espérons que certains sujets intéressant certains pays seront identifiés au cours des discussions dans les prochains jours. Si cela est le cas, ces sujets peuvent être développés en projets de recherche qui seront exécutés conjointement par une équipe IFDC/IFPRI, et un groupe d'analystes nationaux. Nous comptons sur votre connaissance des compétences des différents pays en vue d'identifier des collaborateurs.

L'utilisation des engrais est le résultat d'une série d'événements commençant par la production ou l'importation du produit jusqu'à son utilisation par l'exploitation. L'établissement de politiques favorables à un niveau de la série peut être

contrecarré par des contraintes à un autre niveau, comme celui de l'adoption des engrais par les fermiers. Il est donc très important d'identifier clairement les contraintes principales, et de prendre des mesures équilibrées. Il manque, dans un grande mesure, une analyse nécessaire de la situation des engrais en Afrique. L'une des raisons de cette absence est le défaut de données appropriées. Ce problème est souvent à la base de l'absence de formulation d'une stratégie des engrais. L'IFDC/Afrique compte participer à une collecte de données requises à travers des programmes tels que le Projet de Recherche sur les Politiques. Des efforts parallèles pour la collecte des données sont en cours, concernant:

- La commercialisation et la distribution des engrais
- Les intrants des engrais et leur transformation
- L'utilisation des engrais et leur gestion
- L'utilisation des engrais et leur adoption

Bien que ces projets différents sont d'une importance vitale pour nos efforts, IFDC-Afrique reconnait qu'aucune base de données ne peut remplacer un ensemble de mesures adéquates pris par le gouvernement. C'est pour cette raison que le Programme de Recherche sur les Politiques est considéré comme le joyau de notre effort de recherche. Votre aide durant cette première phase sera hautement appréciée.

J'ai le plaisir de vous présenter l'équipe d'experts qu'IFDC et IFPRI ont apportée à la région pour soutenir cet effort. Tout d'abord, M. Tshikala Tshibaka est le coordinateur de cet effort du côté de l'IFPRI. Il est assisté par la compétence de M. Ahmed, M. Desai, M. Jha, et M. Vasant, pour l'exécution de ce programme. Du côté de l'IFDC, M. Coster opérera à partir du Togo, et sera aidé du siège par M. Baanante et M. Bumb. Prochainement, nous espérons nommer le principal chercheur scientifique pour ce projet, et il sera affecté ici, à Lomé. Ce groupe d'économistes fournira une base solide à ce programme.

Avant de finir, je voudrais exprimer ma sincère gratitude au Gouvernement du Togo, notre pays hôte, pour l'hospitalité qu'il continue à offrir à l'IFDC, en général, et aux participants à cette conférence de travail, en particulier. J'espère que vous retournerez dans vos pays respectifs avec les mêmes sentiments chaleureux pour ce pays que nous, à IFDC, avons ressentis durant notre présence ici.

Je voudrais, enfin, remercier l'USAID, qui finance cet effort important. Plusieurs représentants de l'USAID participent à cette conférence de travail, et cela montre l'importance qu'elle attache au domaine de recherche qui est présenté ici. Cette conférence de travail est une partie intégrale du projet de recherche financé par l'USAID pour une période de cinq ans, et exécuté conjointement par l'IFDC et l'IFPRI. Nous comptons sur la participation de l'USAID à cet effort, et espérons que les résultats seront de valeur à leurs efforts d'assistance pour le développement dans cette région.

Donc, au nom des Directeurs de l'IFDC et de l'IFPRI, je déclare la conférence ouverte, et je vous souhaite beaucoup de succès dans vos délibérations.

Je vous remercie.

Background Note

Tshikala B. Tshibaka

Problems and Workshop Objectives

Since the 1970s, the agricultural situation has been worsening. This phenomenon, combined with a rapid population growth, has not only resulted in a precarious nutritional situation for a large portion of the African population, both rural and urban, but it has also led to a decrease in agricultural surplus. The deteriorating nutritional situation directly affects the health of the population concerned, resulting in a decline in productivity. To mitigate this problem, most African countries import increasing quantities of food products.

The foreign exchange loss, incurred not only as a result of these imports but also as a result of the diminution of the agricultural sector's capacity to generate a substantial surplus, has contributed to a reduction in the volume of financial resources to be invested in promoting the growth of the agricultural sector and of the rest of the economy. Consequently, the entire process of economic development in the region is compromised.

The deterioration of agriculture in the region is explained by the fact that for more than two decades the agricultural productivity has not improved; on the contrary, it actually fell in most cases. The drop in agricultural productivity reflects a decline in productivity of land and labor, two major determinants of the agricultural output in Africa. However, the agricultural policies adopted in the region seem to have been founded, overall, on the conviction that an increase in agricultural production could be realized only by a massive return to the land. In other words, these policies considered the expansion of cultivated areas as an effective means of accelerating the growth of agricultural production in the region.

The studies have demonstrated that, considering the rate of population growth and the present level of crop yields in tropical Africa, the cultivated areas should be increased at an annual rate of 13% in order to maintain growth in cereal production of approximately 4%/year, to meet the food needs of the African population (Mellor and Ranade, 1987). However, it has been estimated that during the period 1961-80 the growth rate of the area under principal food crops in sub-Saharan Africa was only 1.5%/year (Paulino, 1984).

In addition, these studies have shown that in the sub-Saharan zones, where the land is still abundant, it is quite difficult to achieve a noticeable augmentation in crop areas. Furthermore, the slash-and-burn mode of production, practiced in these zones, contributes to the destruction of vegetation and represents, in the long-run, a danger for the ecology of this region, already unstable and delicate. In the zones under considerable population pressure, the expansion of the crop areas cannot be considered. The intensive use of land with traditional production techniques leads to low crop yields and soil degradation. Thus, the intensification of agriculture by means of modern inputs and improved techniques of production must be pursued.

The economic history of Asia demonstrates that the use of modern inputs and improved agricultural techniques contributed not only to higher crop yields but also to an increase in the productivity of labor. This technological change has stimulated the development of related industrial activities and services in most of the Asian countries (Ranjarajan, 1982; Wanmali, 1983; Hazell and Roël, 1983).

Without underestimating the role of other agricultural inputs, studies show that fertilizers can significantly contribute to increased agricultural production in a number of African countries (FAO, 1982; World Bank, 1981). The studies undertaken in the humid zone of tropical Africa show that the use of chemical fertilizers and improved soil management have helped not only to increase the productivity of land and labor but also to stabilize the crop fields and to promote employment in agriculture. In addition, a calculation based on FAO fertilizer trials and world prices shows that, compared with food imports, chemical fertilizer imports result in a substantial saving of foreign exchange (FAO, 1986).

Fertilizer use was recognized during the conference organized by the International Food Policy Research Institute (IFPRI) and the University of Zimbabwe in 1983 as a starting point for all efforts aimed at accelerating food production in tropical Africa in the medium and long terms. It is evident that the diffusion of high-yielding varieties, the selective introduction of pesticides, and the development of irrigation are also necessary for a full technological transformation of agriculture in Africa.

Despite this explicit recognition of the role fertilizers can play, their use in sub-Saharan Africa not only remains extremely limited but also grows less rapidly than in other

developing regions. Although the situation on the whole is far from perfect, it should be pointed out that certain African countries have achieved remarkable progress. However, even in these countries, the use of chemical fertilizers and the introduction of other technical innovations present serious deficiencies. There is, for example, a significant gap between the recommended fertilizer dose and that effectively used. The use of fertilizers remains concentrated on cash crops such as coffee, tea, peanuts, cotton, sugar, and, in certain cases, maize. Overall, food crops are neglected. In addition, large farms receive a disproportionate quantity of these inputs relative to their contribution to output.

In addition, the key indicators to agricultural output show that the general situation in tropical Africa is not promising. The recent economic reforms, operated within the framework of structural adjustment, have proved that in most African countries the use of modern agricultural inputs does not rest on firm bases. In effect, the changes undergone in the domain of prices, credits, and marketing have led to staggering drops in the consumption of fertilizers over the last 3 years or so.

The preceding considerations bring us to the fundamental question to which we must address ourselves: which policy framework is needed to promote, in a stable and long-term manner, the use of fertilizers and other agricultural inputs? Although the region is characterized by a large diversity, the problems of agricultural development by which it is confronted are similar in nature. We believe that this framework should aim at (1) encouraging the use of fertilizers on food and export crops, (2) reducing the divergence between the recommended fertilizer doses and those effectively used, (3) accelerating the fertilization of new lands, (4) promoting the distribution of fertilizers among the small farmers and in areas of low agricultural potential, (5) improving the technical skills of farmers, and (6) increasing the economic efficiency of fertilizer use.

It is important to emphasize that the formulation of this framework requires, at the outset, a profound knowledge of the technical, economic, sociological, and institutional variables affecting the supply and demand of fertilizers. It is from this angle that the present workshop has been organized, with the aim of gathering your views and your recommendations on what you consider, you African policymakers and analysts, to be the major constraints to the development of the fertilizer sector in your respective countries.

We hope that by the end of this seminar it will be possible to derive not only important themes for each country represented but also, and more importantly, regional themes that may become the object of an in-depth analysis that will lead to useful recommendations concerning chemical fertilizer policy. Finally, the International Food Policy Research Institute and the International Fertilizer Development Center emphasize that this effort will be undertaken in close cooperation with the national institutions in the countries concerned.

Procedures, Themes, Reports

The participants will first present their papers. Informal discussion will then follow, with the objective of bringing out the key problems affecting most of the countries represented at this seminar. A background paper, 12 country papers, and 5 technical papers will be presented and will serve as the basis for discussions on the various problems identified in relation to the fertilizer sector.

The Background Note will constitute the reference document for the seminar, while country presentations will examine the problems of the fertilizer sector in individual countries. The presentations by country should be descriptive and analytical to a certain extent and should be organized around the following lines:

1. Fertilizer supply: importation, production, distribution, marketing, and policies.

2. Fertilizer demand: the effect of fertilizer on agricultural productivity, pricing, credit agreements, use of complementary inputs (organic fertilizers, seeds, and pesticides), extension, agricultural research, distribution, marketing, and pricing of agricultural products. The related government policies should be mentioned. The country reports should also present the historical record and the fertilizer consumption profile by crop and by region, if possible.

The five technical reports will focus on the following themes:

1. Fertilizer use in sub-Saharan Africa: regional analysis and reflections.

2. Fertilizer use in Asia: the experience of Bangladesh and other Asian countries.

3. Agronomic considerations relative to the use of mineral and organic fertilizers in sub-Saharan Africa.

4. Microsocioeconomic research on the constraints to fertilizer use in the sub-Saharan region.

The group discussions will build on the following points:

1. Fertilizer procurement policy issues, with reflection on the privatization of the fertilizer sector (production, importation, distribution, and marketing).

2. Policy issues related to fertilizer demand.

3. Aspects of regional cooperation between sub-Saharan countries.

Countries Selected, Participants, Organization, and Logistics

Twelve sub-Saharan countries, representing different levels of agricultural development, have been selected to participate in this seminar: Benin, Côte d'Ivoire, Nigeria, and Togo for Western Africa; Cameroon and Zaire for Central Africa; Zimbabwe, Malawi, and Zambia for Southern Africa; and Kenya for Eastern Africa. One participant per country has been invited. The seminar includes three other participants from international centers directly concerned with the development of the fertilizer sector in the region: the International Institute of Tropical Agriculture (IITA), the International Center for the Improvement of Maize and Wheat (CIMMYT), and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). In addition to the above participants, representatives from the Government of Togo and eight researchers from IFDC and IFPRI, the organizers of this workshop, are also present.

Note Introductive

Tshikala B. Tshibaka

Problématique Et Objectif Du Séminaire

Depuis les années soixante-dix, la situation agricole en Afrique subsaharienne ne cesse de se détériorer et cela à un rythme fort accéléré. Ce phénomène, conjugué à une rapide croissance démographique, a non seulement entraîné une situation nutritionnelle précaire pour une grande partie de la population africaine, tant urbaine que rurale, mais a également occasionné une diminution sensible du surplus agricole. La dégradation de la situation nutritionnelle a des effets directs sur l'état de santé des populations affectées, avec comme conséquence, la diminution de leur productivité. Pour pallier à ce problème, la plupart des pays africains recourent de plus en plus à des importations de denrées alimentaires (commerciales et non commerciales).

La perte des devises - occasionnée par ces importations et par la diminution de la capacité du secteur agricole de dégager un surplus substantiel - se traduit par une réduction du volume des ressources financières à investir, en vue d'assurer la croissance du secteur agricole et celle du reste de l'économie. Tout le processus du développement économique de la région se trouve ainsi compromis.

La détérioration de l'agriculture dans la région s'explique par le fait que depuis plus de deux décennies, la productivité agricole ne s'est guère améliorée ; au contraire, elle a diminué dans la plupart des cas. La diminution de la productivité agricole est le reflet d'une baisse de productivité tant de la terre que de la main d'oeuvre, deux facteurs déterminants de la production agricole en Afrique. Or, les politiques agricoles, adoptées dans la région en vue de faire face à cette situation, semblent être fondées, dans leur ensemble, sur la conviction que l'augmentation de la production agricole peut être réalisée grâce à un retour massif à la terre. En d'autres termes, ces politiques considèrent l'expansion des superficies cultivées comme un moyen efficace pour accélérer la croissance de la production agricole dans la région.

Les études ont démontré, que compte tenu du taux de la croissance démographique et du niveau actuel des rendements des cultures en Afrique tropicale, les superficies cultivées devraient augmenter à un taux annuel de 13 pour cent afin de maintenir une croissance de la production céréalière de 4 pour cent l'an susceptible de répondre aux besoins alimentaires de la population africaine (Mellor et Ranade, 1987). Or, il a été estimé que durant la période 1961-1980, le taux de croissance de la superficie occupée par les principales cultures en Afrique subsaharienne, a été seulement de l'ordre de 1,5 % par an (Paulino, 1984).

En outre, ces études ont montré que dans les zones d'Afrique subsahariennes, où les terres sont encore abondantes, il est bien difficile de réaliser une sensible augmentation des superficies cultivées. De plus, "shifting cultivation", pratiquée dans ces zones, contribue à la destruction de la végétation, et représente, à long terme, un danger pour le complexe écologique de cette région, déjà fort instable et délicat. Dans les zones à forte pression démographique, l'expansion des superficies cultivées n'est pas envisageable. L'utilisation intensive des terres avec des techniques traditionnelles de production aboutit non seulement à de faibles rendements agricoles, mais aussi à la dégradation des sols. Dans les deux cas, le dénouement de cette situation agricole passe nécessairement par l'intensification de l'agriculture au moyen des intrants et des techniques modernes de production.

L'histoire économique de l'Asie montre, en effet, que l'utilisation des intrants modernes de production agricole et des techniques culturales améliorées, a contribué on seulement à l'augmentation des rendements des cultures, mais aussi à la création d'emplois et à l'accroissement de la productivité de la main d'oeuvre agricole. Ce changement technologique est à la base du développement des activités industrielles connexes et des services dans la plupart des pays d'Asie (Ranjarajan, 1982 ; Wanmali, 1983 ; Hazell and Roël, 1983).

Sans sous-estimer le rôle des autres intrants agricoles, les études montrent que les engrais chimiques constituent, à moyen terme, un facteur clé de l'accroissement de la production agricole pour un bon nombre de pays africains (FAO, 1982 ; Banque Mondiale, 1981). Les recherches menées, dans la zone humide de l'Afrique tropicale, montrent que l'utilisation des engrais chimiques, associée à une gestion améliorée de la terre, permet non seulement d'augmenter la productivité de la terre et de la main d'oeuvre, mais aussi de stabiliser les champs de cultures et de promouvoir les emplois agricoles. En outre, un calcul, basé sur les résultats des essais et sur les cours mondiaux, montre que, comparées aux importations de denrées alimentaires, les importations d'engrais chimiques permettent de réaliser des économies substantielles de devises (FAO, 1986).

L'utilisation généralisée des engrais chimiques a été retenue, lors de la conférence, organisée par l'Institut International de Recherche sur les Politiques Alimentaires et par l'Université de Zimbabwe en 1983, comme point de départ de tout effort visant à accélérer la production alimentaire en Afrique tropicale à moyen et à long termes. Il est évident que la mise au point des variétés à hauts rendements et leur diffusion, l'introduction sélective des pesticides et le dévelop-

pement d. .nfrastructures appropriées à l'irrigation, sont également nécessaires à la modernisation complète de l'agriculture africaine.

Malgré cette reconnaissance explicite du rôle que peuvent jouer les engrais dans l'augmentation de la production agricole, leur utilisation, en Afrique subsaharienne, reste non seulement fort limitée, mais elle croît moins rapidement que dans d'autres régions en voie de développement. Bien que dans l'ensemble la situation ne soit pas fort brillante, un certain nombre de pays africains ont réalisé des progrès remarquables qu'il convient de souligner.
Cependant, même dans ces pays, l'utilisation des engrais chimiques et l'introduction des autres innovations techniques présentent de sérieuses déficiences. Il y a, par exemple, un écart important entre la dose d'engrais recommandée et celle effectivement utilisée. L'utilisation des engrais et des semences améliorées reste concentrée sur des cultures de rentes telles que le café, le thé, l'arachide, le coton, le sucre et, dans certains cas, le maïs. Dans l'ensemble, les cultures alimentaires sont négligées. Il convient de souligner également que les grandes fermes agricoles reçoivent une quantité disproportionnée de ces intrants par rapport à leur contribution, à la production agricole.

En outre, les principaux indicateurs de tendance montrent que la situation générale en Afrique tropicale n'est pas prometteuse. Les récentes réformes économiques, opérées dans le cadre des programmes d'ajustements structurels, ont mis en évidence le fait que dans la plupart des pays africains, l'utilisation des intrants modernes de production agricole ne repose pas sur des bases solides. En effet, les changements intervenus dans le domaine des prix, des crédits et de la commercialisation, ont entraîné une diminution sensible de la consommation des engrais en l'espace de deux ans.

Les considérations qui précèdent, amènent à cette question fondamentale à laquelle nous devons apporter des réponses : quel est le cadre politique à mettre en place en vue de promouvoir, d'une manière soutenue, l'utilisation des engrais et des autres intrants agricoles ? Bien que la région se caractérise par une grande diversité, les problèmes de développement agricole, auxquels elle se trouve confrontée, sont de natures similaires. Nous pensons que ce cadre doit viser à : (1) encourager l'utilisation des engrais sur les cultures vivrières et d'exportation ; (2) réduire la divergence entre les doses d'engrais recommandées et celles effectivement appliquées ; (3) accélérer la fertilisation des nouvelles terres ; (4) promouvoir la diffusion des engrais parmi les petits agriculteurs et dans les zones à faibles potentialités ; (5) améliorer les capacités techniques des agriculteurs ; (6) augmenter l'efficacité économique de l'utilisation des engrais.

Il est important de souligner que l'élaboration de ce cadre exige, en premier lieu, une connaissance approfondie des variables techniques, économiques, sociologiques et institutionnelles affectant l'offre et la demande en engrais. C'est dans cette optique qu'a été organisé le présent séminaire. Cette rencontre vise à recueillir vos points de vues et recommandations sur ce que vous considérez - vous les décideurs africains - étant des contraintes majeures au développement du secteur des engrais dans vos pays respectifs.

Nous espérons qu'à l'issue de ce séminaire, il sera possible de dégager, non seulement des thèmes importants pour chaque pays représenté, mais aussi et surtout des thèmes à caractère régional, qui pourront faire l'objet d'un effort d'analyse approfondie, susceptible de déboucher sur des recommandations utiles en matière de politique d'engrais chimiques. Enfin, l'Institut International de Recherche sur les politiques Alimentaires (IFPRI) et le Centre International pour le Développement des Engrais (IFDC Afrique) soulignent que cet effort de recherche sera mené en collaboration étroite avec les institutions nationales dans les pays concernés.

Démarche, Thèmes, Exposés

Les participants présenteront d'abord leurs exposés. Des discussions de type informel seront ensuite engagées en vue de faire ressortir les principaux problèmes touchant la plupart des pays représentés à ce séminaire.

Un exposé introductif, 12 exposés par pays et 5 exposés techniques seront présentés et serviront de base pour les discussions sur les divers problèmes, identifiés dans le domaine de la politique des engrais.

L'exposé introductif constituera le document de références pour les travaux du séminaire, tandis que les présentations par pays examineront les problèmes inhérents au secteur des engrais. Les présentations par pays devront être descriptives et critiques dans une certaine mesure, et devront s'organiser autour des points suivants :

(1) Les problèmes relatifs à l'approvisionnement en engrais : importation, production, distribution, commercialisation et politiques ;
(2) Les problèmes liés à la demande des engrais : effets des engrais sur la productivité agricole, fixation des prix, accords de crédits, utilisation des intrants complémentaires (engrais organiques, semences, et pesticides), vulgarisation, recherche agricole, distribution, commercialisation et fixation des prix des produits agricoles.

Les politiques gouvernementales concernant ces divers problèmes devront être mentionnées. Les exposés par pays devront également présenter l'historique et les schémas d'utilisation des engrais par culture et par région (si possible).
Les cinq exposés techniques présentés porteront sur les thèmes suivants :

(1) L'utilisation des engrais en Afrique subsaharienne : analyse régionale et réflexions ;
(2) l'utilisation des engrais en Asie : l'expérience du Bangladesh et des autres pays asiatiques ;
(3) les aspects agronomiques relatifs à l'utilisation des

engrais minéraux et organiques en Afrique subsaharienne;

(4) la recherche micro socio-économique sur les contraintes inhérentes à l'utilisation des engrais en Afrique subsaharienne dans le contexte du développement de politiques ;

(5) les stratégies et les politiques susceptibles d'améliorer la diffusion des informations sur les engrais dans la région sub saharienne.

Les discussions de groupe porteront sur les points suivants :

(1) Les problèmes relatifs aux politiques d'approvisionnement en engrais, avec une réflexion sur la privatisation du secteur des engrais (production, importation, distribution et commercialisation) ;

(2) les problèmes et les politiques relatifs à la demande en engrais ;

(3) les aspects de la coopération régionale entre les pays d'Afrique subsaharienne.

Pays Sélectionnés, Participants, Organisation Et Logistique

Douze pays d'Afrique subsaharienne, représentant des niveaux différents de développement agricole, ont été sélectionnés pour participer à ce séminaire : le Bénin, la Côte d'Ivoire, le Nigéria, le Togo, pour l'Afrique de l'Ouest : le Cameroun et le Zaïre pour l'Afrique centrale, le Zimbabwe, le Malawi et la Zambie pour l'Afrique australe et le Kenya pour l'Afrique de l'Est. Un participant par pays a été invité .

Le séminaire compte aussi trois autres participants provenant de centres internationaux, directement concernés par le développement du secteur des engrais dans la région : l'Institut International d'Agriculture Tropical (IITA), le Centre International pour l'Amélioration du Maïs et du Blé (CIMMYT), and l'Institut International de Recherche sur les Cultures des Zones Tropicales Semi-Arides (ICRISAT).

A ce nombre de participants, il convient d'ajouter le représentant du Gouvernement togolais et huit chercheurs du Centre International pour le Développement des Engrais (IFDC) et de l'Institut International de Recherche sur les Politiques Alimentaires (IFPRI), organisateurs de ce séminaire.

Part I

Fertilizer Policies in Selected Sub-Saharan Countries

Fertilizer Policy in Benin

Tetevi R. Vinyor

The bulk of agricultural output in Benin is produced by smallholder farmers using simple tools, local crop varieties, and traditional techniques. Fertilizers and other modern inputs are not recognized as essential in the agricultural productivity growth process. Given the centrality of fertilizer in this process, the Government of Benin decided to handle, through a parastatal (Société Nationale pour la Promotion Agricole [SONAPRA]), the procurement, distribution, and marketing of fertilizer. This government-controlled delivery system does not operate efficiently. Fertilizers often do not reach the farms when they are most needed, and late applications result in a low level of response.

Fertilizer use was formerly subsidized, but in 1982/83 the government started to phase out the subsidies. The price of fertilizer was increased during the same year from 25 FCFA per kg to 45 FCFA, representing an 80% increase. In 1983/84, the nominal rate of subsidy was about 47%. In 1987/88, fertilizers ceased to be subsidized and were taxed at the rate of 10%. Fertilizers are sold on credit. During the sale of the produce to SONAPRA, the amount of this credit is deducted.

Fertilizer procurement is mainly financed by bilateral and multilateral agencies, including the World Bank, la Caisse Centrale de Coopération Economique, Fonds Français d'Aide et de Coopération, and the International Fund for Agricultural Development (IFAD). The bulk of these fertilizers is for export crops, mainly cotton. The difference between the estimated fertilizer needs and the quantities provided by the above agencies is financed by SONAPRA with credit from the local banks. SONAPRA is plagued by financial difficulties for a variety of reasons, including poor management.

Efforts to promote a local fertilizer industry appear to have failed. A bulk blending plant built in 1983 has never been operational, partly because of the lack of working capital but mostly because the price of fertilizer blended in the country is much higher than that of imported brands. In addition, the estimated value added of the whole operation would be about 10% of the cost of raw materials, representing half of what the World Bank accepts as the low limit.

Research on fertilizers has been concentrated on export crops such as palm oil, groundnut, cotton, and tobacco. And among these crops, cotton has received the lion's share of resources allocated to research. This reflects the interest of French research centers that constitute the main research network operating in Benin. As a result of this deliberate policy, 88%-96% of fertilizer is used on cotton. Food crops have received little attention in this regard. The diffusion of fertilizers in the country remains limited. Fertilized area increased from 3.5% of the total cropped area in 1982/83 to about 10% in 1986/87.

La Politique de l'Engrais en République Populaire du Bénin

Tetevi R. Vinyor

En République Populaire du Bénin, la quasi-totalité de la production agricole est assurée par les petits paysans disposant d'exploitations agricoles aux superficies limitées (1,50 ha à 2,50 ha par famille) et des moyens de production rudimentaires : houe, coupe-coupe, hache. Sur le plan technique, la mécanisation motorisée (utilisation du tracteur) est très limitée et la culture attelée est quelque peu développée dans les provinces septentrionales, mais à une échelle encore réduite. Très tôt, il est donc apparu qu'une politique tendant à une augmentation de la production doit tenir compte du niveau technique relativement bas de l'agriculteur béninois et mettre en oeuvre, en premier lieu, des mesures simples, peu coûteuses et efficaces. Parmi ces mesures, l'utilisation des engrais et des pesticides est considérée comme une pratique capitale pour l'amélioration de la productivité, sans augmentation de la taille de l'exploitation. Concernant les engrais en particulier, les autorités béninoises ont mis en application un certain nombre de mesures, découlant directement des objectifs de la politique agricole adoptée.

Quelques Objectifs de la Politique Agricole en République Populaire du Bénin

Nous citerons ici, les objectifs qui justifient la mise en oeuvre d'une politique d'utilisation des facteurs de production que sont les engrais et les pesticides.

(1) L'objectif prioritaire est d'assurer l'autosuffisance alimentaire, en résolvant quantitativement et qualitativement, le problème de l'alimentation de toute la population béninoise. Ainsi, dans les programmes de développement, la priorité est donnée aux cultures vivrières, en particulier les céréales, les tubercules et les légumineuses.

(2) Ravitailler en matières premières les industries de transformation : il s'agit en fait de promouvoir la production des cultures industrielles et les industries de transformation qui utilisent les matières premières agricoles. L'objectif tend également à l'utilisation à pleine capacité, des industries alimentaires qui produisent des biens de consommation pour le marché local et pour l'exportation.

(3) Susciter, par l'accroissement de la demande en biens d'équipement et autres facteurs de production, le développement des industries mécaniques et chimiques. Ici, l'agriculture doit être demandeur de biens d'équipement et surtout de facteurs de production, produits par l'industrie locale ; nous mentionnerons en particulier, les engrais et les pesticides.

(4) Constituer des réserves alimentaires en vue de faire face efficacement aux périodes de soudure et aux années de mauvaise production. Ainsi, la sécurité alimentaire vient se placer après l'autosuffisance alimentaire et reste un objectif primordial.

(5) Dégager des surplus pour l'exportation en vue d'accumuler des devises pour l'acquisition de biens d'équipement. Dans la formulation de la politique agricole, l'exportation des produits agricoles intéresse aussi bien les cultures industrielles traditionnelles, que les cultures vivrières. En effet, la position particulière du Bénin, à côté du grand voisin qu'est le Nigéria et au Sud des pays enclavés comme le Niger et le Burkina Faso, fait que, pour les paysans béninois, les cultures vivrières constituent également des cultures de rente, en particulier les céréales et les tubercules faisant l'objet de transactions importantes aux marchés frontaliers.

(6) Constituer un marché d'envergure pour les produits industriels, alimentaires et manufacturés, grâce à l'amélioration du niveau de vie et du revenu des agriculteurs. Cet objectif implique l'existence d'une production commercialisable, donc en ce qui concerne les cultures vivrières, une production supérieure à la consommation. De plus, le développement des transactions commerciales doit permettre d'obtenir des débouchés pour les excédents.

(7) Lutter contre la culture itinérante afin d'éviter la destruction de l'environnement, en favorisant la culture intensive et la sédentarisation des agriculteurs. Voilà un élément fondamental de la politique des engrais, car la mise en oeuvre de cet objectif est très étroitement liée à la restauration et au maintien de la fertilité du sol.

Tous ces objectifs doivent concourir à l'augmentation de la production agricole, aussi bien pour les cultures vivrières que pour les cultures industrielles.

Comment la Réalisation de ces Objectifs Peut-Elle Conduire a La Formulation Et A La Mise En Oeuvre D'Une Politique Rationnelle D'Utilisation Des Engrais

Pour obtenir l'augmentation de la production visée par ces objectifs, il importe de concevoir des actions qui prennent en compte certains éléments objectifs de l'agriculture béninoise. Quels sont ces éléments ?

La Taille des Exploitations Agricoles

La taille réduite des exploitations agricoles est due à la pression démographique en zone rurale dans le Sud du pays, et au manque de main d'oeuvre agricole dans le Nord.
Ainsi, la pression démographique dans le Sud a conduit à un morcellement de l'exploitation agricole, rendant pratiquement

impossible une augmentation de superficie, même au niveau des familles disposant de la main d'oeuvre.
Par contre, dans le Nord où la disponibilité de la terre n'est pas un facteur limitant, l'insuffisance de la main d'oeuvre agricole rend difficile l'extension des superficies, sauf dans les cas d'utilisation de la culture attelée.

Le Niveau Technique des Agriculteurs

L'agriculture béninoise est encore dominée par les petits paysans aux moyens techniques rudimentaires. La plupart des agriculteurs travaillent encore à la main, avec des outils traditionnels comme la houe, le coupe-coupe, la hâche. Même dans les régions, où la famille compte beaucoup de bras valides, ces instruments sont peu propices à un accroissement de l'exploitation.
Il est donc clair que la mise en oeuvre des objectifs, concourant à une augmentation de la production agricole, doit déboucher nécessairement sur l'augmentation de la productivité. Dans des conditions écologiques normales, l'utilisation de l'engrais est un facteur pouvant assurer une amélioration sensible de cette productivité. En outre, l'utilisation rationnelle des engrais peut permettre de mettre fin à la pratique de la culture itinérante contribuant à la dégradation de l'environnement.

La Formulation De La Politique De L'Engrais Par Les Autorités Béninoises

La politique de l'engrais a été formulée de la manière suivante, publiée dans les documents officiels , sous la dénomination : "chimisation".

La sauvegarde et l'encouragement de l'effort du paysan passe par l'utilisation rationnelle des engrais et des pesticides. Pour cette raison, il faut veiller à un approvisionnement régulier du monde rural en quantité et en qualité de ces deux facteurs. Une meilleure sécurité dans l'approvisionnement doit être assurée par la fabrication sur place des produits, en temps opportun et à la composition voulue. Il est en conséquence urgent, de tout mettre en oeuvre pour le démarrage effectif, à GODOMEY, province de l'Atlantique, de l'unité de reformulation d'engrais et de la construction de l'unité de reformulation de pesticide.

Dans cette formulation, apparaissent certains éléments essentiels de la politique de l'engrais : l'approvisionnement en quantité suffisante, la qualité adéquate, la production sur place, la distribution en temps voulu.

Les Actions Menées Dans Le Cadre De La Politique De L'Engrais En République Populaire Du Bénin

L'approvisionnement

L'utilisation de l'engrais par le paysan est conditionnée par la disponibilité du produit. D'une façon générale, les structures privées traditionnelles du secteur tertiaire sont présentées en zone rurale surtout au moment de la commercialisation des produits agricoles, pour offrir au monde paysan des produits manufacturés et des produits de consommation de toutes sortes. Cependant, elles ne se préoccupent guère de mettre à la disposition des agriculteurs, en période de culture, les facteurs de production dont ils ont besoin.

L'Etat a donc pris en main la question de l'approvisionnement du monde rural en intrants agricoles. L'approvisionnement en engrais est assuré au niveau central par la Société Nationale pour la Promotion Agricole (SONAPRA). Elle centralise les besoins, lance les appels d'offres, procède aux dépouillements et aux adjudications, passe les commandes, assurent les paiements, réceptionne les produits et approvisionne les organismes régionaux de développement (CARDER) en vue de la distribution au niveau des paysans.

Dans le processus devant aboutir à la livraison des engrais aux paysans, la question fondamentale reste la disponibilité des produits dans les villages au moment où les agriculteurs en ont besoin, c'est-à-dire au mois de mars, pour les semis de céréales dans la zone méridionale du pays, et au mois de mai pour les mêmes cultures de la zone septentrionale. Cependant, en pratique, les cultures industrielles recevant la plus grande partie de la fumure, le mois de Juin est considéré comme la période limite d'approvisionnement.

Cependant, un autre facteur vient interférer sur ces dates. En effet, en vue de réduire les coûts de distribution des engrais, l'idéal consisterait à profiter des retours à vide des camions chargés de ramasser dans les villages, les produits agricoles commercialisés par les organismes d'Etat. Il s'agit du coton, de l'arachide, des régimes de palme, du karité. Or, les opérations d'achat de ces produits, démarrant au plus tard en janvier, l'utilisation des moyens de transport correspondant, nécessitent que les intrants agricoles, dont les engrais en particulier, soient disponibles au plus tard en janvier au niveau des organismes régionaux de développement : les CARDER.

Cette exigence, reflétant une idée théorique, est représenté par le calendrier d'approvisionnement suivant :

AVRIL	: Expression des besoins par les paysans au niveau des CARDER pour la campagne suivante.
MAI	: Transmission des besoins par les CARDER à la SONAPRA, tenant compte des stocks prévisionnels de la campagne en cours.
JUIN	: Préparation des cahiers d'appel d'offres par la SONAPRA.
JUILLET :	Approbation des cahiers d'appels d'offres par les autorités et lancement de l'appel d'offres.
OCTOBRE	: Dépouillement, adjudication.
NOVEMBRE	: Commande - Délai de livraison : 90 jours.
JANVIER	: Réception au Port de COTONOU.
FEVRIER A AVRIL	: Mise en place.

Dans la plupart des cas, les engrais ne sont débarqués au port de COTONOU qu'aux mois de mars ou avril.

La Distribution

La politique de distribution mise en oeuvre tient largement compte de la situation objective des paysans, se trouvant dans l'impossibilité de parcourir de longues distances par manque de moyens de transport pour s'approvisionner en intrants agricoles. En conséquence, le gouvernement a assigné aux CARDER, la mission de mettre en place les facteurs de production jusqu'au niveau du village. L'engrais livré à ce niveau est stocké par les groupements villageois ou par les responsables de la collectivité villageoise, dans des abris, sous la responsabilité des agents d'encadrement. Comme précédemment mentionné, l'acheminement des produits est assuré autant que possible par les camions venant ramasser les produits agricoles commercialisés au niveau du village. La distribution aux paysans est faite pendant la période d'épandage.

La Qualité des Engrais

L'expérience accumulée dans la mise en oeuvre de la politique d'approvisionnement, a amené les autorités béninoises à accorder une attention particulière à la qualité des engrais livrés et à prendre certaines précautions pour garantir cette qualité.

En effet dans le passé, la société chargée d'assurer les commandes et la réception des engrais a connu quelques difficultés avec les fournisseurs :

— Livraison de produits n'ayant pas la composition demandée notamment pour l'engrais NPKSB dont certains éléments, en particulier le phosphore et le potassium, sont sous-dosés.

— Livraison de produits relevant certains défauts n'apparaissant qu'à l'utilisation. Par exemple, il y eut une livraison d'engrais granulés insolubles.

Dans la plupart des cas, les défauts ne sont décelés qu'avec l'apparition de certaines anomalies au niveau des cultures : développement végétatif important au détriment de la floraison en cas de déséquilibre des composants, développement insuffisant en cas d'insolubilité de l'engrais.

Face à ces phénomènes,certaines précautions ont été prises:

(1) Approvisionnement direct auprès des fabricants d'engrais dans la mesure du possible.

(2) Engagement du fabricant à livrer les produits lorsqu'il s'agit d'une société commerciale.

(3)Analyse contradictoire effectuée par un laboratoire indépendant du fournisseur.

Ainsi, depuis quelques années, la qualité des engrais a été sauvegardée, grâce à ces mesures.

Depuis un an, pour pallier aux changements de fabricants par les sociétés commerciales qui, après avoir soumissionné à un certain prix, partent à la recherche de stocks en liquidation à des prix nettement inférieurs, il est exigé une caution solidaire entre le commerçant et le fabricant.

La Politique de Prix

Subvention. Pendant plusieurs années, le gouvernement béninois a pratiqué une politique de subvention systématique de l'engrais, afin d'inciter les paysans à l'utilisation de ce produit.

Jusqu'à la campagne 1981-1982, l'engrais était vendu à 25 FCFA le kilogramme, quel que soit son prix de revient, ce qui entraînait un taux de subvention parfois supérieur à 75 %.

La campagne 1982-1983 a remarqué une augmentation du prix qui est passé à 45 FCFA le kilogramme.

A partir de cette année, la Banque Mondiale qui, dans le cadre du financement des projets de développement rural intégré, accordait des crédits pour l'acquisition des intrants agricoles (engrais et pesticides), a mis en cause la politique de subvention.

Dès lors, il a été décidé de réduire progressivement le taux de subvention pour aboutir à un prix de vente de l'engrais au paysan correspondant à son prix de revient bord champ.

Le tableau 1 indique l'évolution des prix et du taux de subvention.

Tableau 1. **Evolution des Prix des Engrais en FCFA/KG et du Taux de Subvention pour les Campagnes de 1981 a 1988**

Années	80-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88
Prix de revient	-	-	-	113	111	139	127	91
Prix de cession	25	25	45	60	60	90	90	100
Taux de cession [en pourcentages]	-	-	-	60	50	40	30	0

Prix de Revient. Depuis toujours, l'un des soucis des autorités béninoises a été d'acquérir des engrais de bonne qualité et au prix le plus économique.

Deux dispositions permettent de réduire le prix des engrais :

(1) l'acquisition par la procédure d'appels d'offres : elle permet au moment du dépouillement et du jugement des offres de choisir le meilleur binôme qualité-prix, permettant d'obtenir un produit de bonne qualité au prix le plus intéressant.

(2) la réduction des frais d'approche, et plus particulièrement des frais de distribution et de mise en place : le principe retenu est d'employer le retour à vide des camions affectés, à la commercialisation des produits agricoles, pour la mise en place des engrais jusqu'au niveau du village. Nous avons signalé que cette disposition connaît certaines insuffisances à cause du débarquement tardif des engrais au port de COTONOU. Mais, dans la zone septentrionale, où le ramassage du coton et de l'arachide se poursuit jusqu'au mois de juin, la mise en oeuvre de la disposition est possible pour beaucoup de villages.

La Politique de Crédit

Une autre disposition prise par les autorités béninoises pour favoriser l'utilisation des engrais par les paysans, est la vente à crédit.

Les engrais sont livrés à crédit aux paysans au moment de

l'utilisation. Le remboursement intervient au moment de la commercialisation des produits agricoles.

En pratique, au moment de la livraison de l'engrais, un bon d'achat est délivré au paysan par l'intendant ou l'encadreur, portant la quantité livrée, le prix unitaire et le coût total. Lorsqu'intervient, à la fin de la campagne agricole, la vente des produits agricoles aux organismes officiels de commercialisation, la valeur de l'engrais livré est déduite de celle des produits vendus avant le paiement à l'agriculteur.

Une question se pose alors : comment la SONAPRA finance-t-elle l'acquisition des engrais ?

Deux modes de financement interviennent :

(1) une partie des engrais est financée par les bailleurs de fonds : Banque Mondiale, Caisse Centrale de Coopération Economique, Fonds Français d'Aide et de Coopération, Fonds International pour le Développement Agricole, Fonds de l'OPEP etc... Il s'agit des quantités d'engrais prévues dans le cadre de projets financés par ces organismes. Ce financement intéresse les quantités additionnelles d'engrais, c'est-à-dire, le surplus d'engrais consommé chaque année par rapport à l'année précédente. Très souvent, il s'agit d'ailleurs d'engrais destinés aux cultures industrielles.

(2) La différence entre les besoins totaux et les quantités financées par les bailleurs de fonds, est payée par la SONAPRA, sur un crédit de campagne, accordé par le consortium des banques nationales.

En pratique, la totalité des engrais commandés est payée par crédit bancaire ; les bailleurs de fonds ne remboursant la SONAPRA qu'après réception des produits sur présentation des demandes de remboursement, accompagnées des pieces justificatives.

Une autre question qui se pose alors est de savoir quel est le taux du crédit consenti par les banques ; le taux de ce crédit est-il répercuté sur le prix de revient, donc sur les revenus du paysan ?

Le crédit de campagne destiné à l'acquisition des intrants agricoles est consenti par les banques à la SONAPRA au taux normal, actuellement de 13 %. Cependant, les frais financiers répercutés sur le prix de revient des engrais varient d'une année à l'autre en pourcentage, et dépendent de la proportion des engrais remboursée par les bailleurs de fonds. Ce remboursement intervient en général trois à quatre mois après le dénouement des crédits documentaires ce qui correspond au maximum à 6 mois de crédit bancaire. La part de financement payée par la SONAPRA n'est remboursée aux banques qu'après paiement par les paysans de la valeur des engrais livrés, ce qui correspond à 12 à 14 mois de crédit, mais, lorsque des disponibilités financières existent, la SONAPRA accorde un crédit avant le remboursement par les paysans, afin de limiter les frais financiers.

Le tableau 2 indique les prix de revient depuis la campagne 1983-1984 et il permet de prendre conscience de l'importance des frais financiers.

Pour les deux dernières années, l'importance des frais financiers s'explique par la réduction sensible des quantités additionnelles financées par les bailleurs de fonds et par les difficultés financières de la SONAPRA, entraînant un allongement de la durée du crédit bancaire.

Tableau 2. **Prix de Revient des Engrais en FCFA/KG Pour les Campagnes de 1984 a 1988**

Années	83-84	84-85	85-86	86-87	87-88
Valeur moyenne en FCFA	91,26	91,41	113,58	91,31	62,67
Frais de transit	5,84	5,02	5,70	9,99	6,52
Frais de transport	5,06	5,14	10,57	7,47	7,05
Frais financiers	4,13	2,72	2,04	11,29	7,52
Frais d'approche	7,00	7,00	7,00	7,00	7,00
Prix de revient	113	111	139	127	91

La Politique de Production

Dès 1976, dans le cadre de l'élaboration du Premier Plan Triennal d'Etat et en raison des objectifs d'autosuffisance alimentaire qui impliquaient une augmentation notable de la production agricole, les autorités béninoises avaient décidé de généraliser l'utilisation des engrais sur les cultures vivrières, en particulier sur les céréales et les tubercules, en vue d'améliorer la productivité.

Il avait dont été prévu qu'au terme du plan, en 1979, la consommation annuelle d'engrais serait la suivante :

- Maïs	42.185 tonnes
- Manioc	27.265 tonnes
- Haricot	3.140 tonnes
- Coton	9.168 tonnes
TOTAL	82.208 Tonnes

Ces prévisions très optimistes de consommation d'engrais étaient à l'origine de l'étude, dès 1977, d'un projet d'installation d'une unité de reformulation d'engrais, du type "bulk blending". La capacité moyenne prévue était de 90.000 tonnes avec la possibilité de produire 160.000 tonnes en fonctionnant à un rythme continu avec trois équipes de travail suivant la demande extérieure.

L'installation de cette unité a connu quelques difficultés et s'est terminée en 1983.

L'objectif poursuivi était de deux ordres :

(1) pouvoir formuler à la demande, des types d'engrais correspondant à chaque type de culture et à chaque zone écologique.

(2) mettre l'engrais à la disposition des paysans en temps voulu ; programmer la formulation sur une période convenable afin d'optimiser l'utilisation des moyens de transport, lors de la mise en place des produits au niveau des villages.

Malheureusement jusqu'à ce jour, l'usine n'a jamais été productive en raison du manque de fonds de roulement. En réalité, les bailleurs de fonds, estimant que le prix de revient de la formulation risquait d'être plus élevé que le coût d'acquisition direct, n'ont jamais accepté que les fonds mis à

la disposition du Bénin pour l'acquisition d'engrais, soient affectés au fonctionnement de l'unité de reformulation.

La Recherche

Elle doit permettre de répondre aux questions préalables à toute utilisation d'engrais :

- Quelle est la formule d'engrais qui correspond à chaque type de culture dans une zone écologique donnée ?
- Quelle quantité d'engrais utiliser pour maintenir le niveau de fertilité du sol ?
- Comment utiliser l'engrais pour assurer le maximum d'efficacité : périodes d'épandage, fractionnement, etc...?

En République Populaire du Bénin, la recherche agronomique initiée très souvent par les instituts français de recherche, et financée la plupart du temps par les bailleurs de fonds, ne s'est préoccupée d'établir des formules complètes d'engrais que pour les cultures d'exportation : palmier à huile, arachide, coton, tabac.

La recherche sur le coton est plus particulièrement minutieuse où jusqu'ici, l'Institut de Recherche sur le coton et la fibre, précise, chaque année, la composition de l'engrais à utiliser pour cette culture. Ce sont ces prescriptions qui guident la SONAPRA dans les commandes d'engrais. Les recherches ont ainsi mis en évidence, des carences en souffre et en bore pour certaines régions, ce qui justifie la formule actuellement utilisée sur le coton : NPKSB : 25-25-15-5-1.

Parmi les cultures vivrières, seule le maïs fait l'objet d'indications d'ailleurs imprécises concernant l'utilisation de sulfate d'ammoniaque ou d'urée, à une dose variant entre 50 et 100 kgs l'hectare. Les autres cultures vivrières ne bénéficient d'aucune attention particulière. Il est simplement recommandé de les semer, en particulier pour le maïs et le sorgho, derrière un coton qui a reçu de l'engrais, afin de profiter de l'arrière effet de la fumure.

Au Bénin, cette situation est essentiellement due au Bénin, au manque de ressources financières pour financer la recherche. Les seuls financements affectés à la recherche sont fournis par les bailleurs de fonds qui ne s'intéressent qu'aux cultures d'exportation. Actuellement seule la recherche sur le coton reçoit encore des financements extérieurs importants de la part de la Banque Mondiale et du Gouvernement français.

Les Résultats Obtenus

Quelles sont les conséquences de toutes ces mesures sur la consommation d'engrais en République Populaire du Bénin ? (Cf. tableau 3)

On constate une augmentation des quantités d'engrais d'une année à l'autre et ce phénomène est essentiellement dû à l'essor du coton qui a connu un succès remarquable depuis 1982.

Néanmoins, les superficies fumées restent faibles par rapport aux superficies totales. En 1986, où l'utilisation des engrais a été la plus importante, les superficies fumées estimées atteignaient à peine 10 % des superficies totales semées.

Les Insuffisances Et Les Contraintes

La mise en oeuvre correcte de la politique des engrais, telle qu'elle est définie par les pouvoirs publics, se heurte à un certain nombre de difficultés. Nous sommes forcés de constater qu'entre les objectifs affirmés de la politique des engrais, les moyens et les dispositions mis en oeuvre, il y a une contradiction flagrante.

Limitation de l'Utilisation d'Engrais aux Seules Cultures Industrielles

En pratique, pour certaines raisons qui seront évoquées plus loin, seules les cultures industrielles ou cultures d'exportation sont fumées par les paysans : coton, arachide, tabac, palmier à huile, pourtant, la culture du coton absorbe actuellement la quasi- totalité des commandes d'engrais, comme le démontre le tableau 4.

On s'aperçoit que le binôme NPK + urée, formé par les engrais destinés au coton absorbe 88 à 96 % selon les années, des commandes d'engrais. Quand on sait que le supertriple et le sulfate d'ammoniaque sont destinés en priorité à l'arachide dans la Province de l'Atacora, on en déduit que les cultures vivrières ne reçoivent pratiquement pas d'engrais. Plusieurs éléments expliquent cette situation :

a) Les structures de vulgarisation, chargées de susciter les demandes d'engrais et d'assurer la répartition des produits sur le terrain, ne s'intéressent qu'au engrais destinés aux cultures de rente, faisant l'objet d'une commercialisation par les structures d'Etat. La facilité de rentabilisation des frais des intrants, lors de la vente des produits agricoles, est l'une des raisons majeures. En effet, il faut reconnaître que le paysan est parfaitement favorable à l'utilisation de l'engrais sur la plupart de ses cultures, car il connaît l'effet sur le rendement. Cela explique quelques cas de détournements des engrais, destinés aux cultures industrielles sur les céréales.

b) D'une manière générale, la recherche sur les cultures vivrières est négligée à cause de l'insuffisance du financement intérieur et de l'inexistence d'aide extérieure. Ainsi, bien que les paysans connaissent l'effet nettement positif de l'engrais sur les céréales, les recommandations des services de vulgarisation se limitent à l'emploi de 50 à 100 kgs d'urée ou de sulfate d'ammoniaque sur le maïs ou le sorgho. Le plus simple reste la recommandation faite aux paysans de semer le maïs ou le sorgho derrière un coton fumé, pour profiter de l'arrière effet de l'engrais.

c) Les bailleurs de fonds ne prennent en compte, pour le financement des projets agricoles, que des quantités additionnelles d'engrais destinées aux cultures d'exportation.

d) Les contraintes du calendrier ne facilitent pas l'expression des besoins en engrais par les paysans. En effet, la procédure d'acquisition par appels d'offres exige

Tableau 3. **Quantités D'Engrais Consommées (en Tonnes) et Superficies Cultivées (en Hectares) Pour les Campagnes de 1983 a 1989**

	82-83	83-84	84-85	85-86	86-87	87-88	88-89
Engrais	6.441	9.896	16.207	20.017	22.107	21.410	14.967
Superficies fumées	32.205	49.480	81.035	100.085	110.535	107.050	-
Superficies totales cultivées	911.186	963.006	1.022.933	1.101.035	1.109.307	-	-
pourcentage de superficies fumées	3,53	5,14	7,92	9,09	9,95	-	-
Superficies fumées pour le coton	26.926	39.673	56.511	83.217	102.708	-	-

Tableau 4. **Répartition des Engrais Commandés depuis la Campagne 1982-1983**
(en tonnes pour chaque catégorie)

	82-83	83-84	84-85	85-86	86-87	87-88	88-89
NPK	4.444	5.739	9.688	12.860	14.850	13.830	10.641
UREE	1.373	3.202	5.525	3.965	4.967	5.020	3.720
Total 1	5.817	8.941	15.213	16.825	19.817	18.850	14.361
T.S. phosphate	375	676	392	1.450	1.244	960	524
Sulfate d'ammoniaque	150	194	72	82	35	0	0
Phosphate d'ammoniaque	0	22	49	1.300	640	1.600	0
Chlorure de potasse	99	63	460	300	339	0	82
sulfate de potasse	0	0	21	60	0	0	0
Phosphate bicalcique	0	0	0	0	32	0	0
Total 2	624	955	994	3.192	2.290	2.560	606
Total 1 + 2	6.444	9.896	16.207	20.017	22.107	21.410	14.967
% NPK + UREE	90,31	90,35	93,87	84,05	89,64	88,04	95,95
% autres engrais	9,69	9,65	6,13	15,95	10,36	11,96	4,05
Total Pourcentages	100	100	100	100	100	100	100

l'application rigoureuse d'un calendrier permettant l'arrivée des engrais en janvier ou en février, pour que la mise en place soit terminée avant le début de la saison des pluies : au mois de mars au Sud et au mois de mai au Nord. Le personnel d'encadrement est donc amené à demander aux paysans, dès le mois de mars ou avril, leurs besoins en engrais pour l'année suivante. Or au mois de mars ou avril, l'engrais de l'année en cours n'est pas encore utilisé et certains paysans ne l'ont même pas encore reçu ; d'où la difficulté d'apprécier les stocks prévisionnels de fin de campagne. La conséquence est l'existence d'importants reports de stocks d'une année à l'autre, avec tous les problèmes de stockage que cela comporte, de détérioration et de pertes. Le financement de ces stocks nécessite parfois des fonds importants.

e) La limitation du crédit de campagne aux seuls intrants destinés aux cultures d'exportation, ne favorise pas l'utilisation des engrais sur les cultures vivrières. Compte tenu du fait que la récupération du crédit de campagne est liée à la commercialisation des produits agricoles, il a été retenu que les ventes d'engrais pour les cultures vivrières, en particulier les céréales, doivent se faire au comptant pour éviter les impayés, de plus que le maïs et le sorgho sont vendus par des circuits traditionnels.

Cette décision de vente au comptant des engrais destinés aux cultures vivrières, revient purement et simplement à nier la nécessité d'utilisation des intrants agricoles sur ces cultures. En effet, la période de livraison des facteurs de production, correspond toujours à la période de soudure, où les disponibilités financières des paysans sont quasi-inexistantes. Comment, dès lors, espérer qu'ils puissent acheter au comptant de l'engrais dans une situation aussi difficile.

f) La commercialisation des produits agricoles :
Comme mentionné ci-dessus, le mode de commercialisation des produits vivriers constitue un frein à l'exten-

sion du crédit agricole pour les intrants destinés aux cultures vivrières. En effet, les produits d'exportation sont commercialisés par la SONAPRA, qui utilise les dispositifs des CARDER pour procéder à leur collecte. Au niveau de chaque marché, le paysan touchera des produits livrés, moins la valeur des engrais et autres intrants achetés.

Malgré l'existence de l'Office National des Céréales, la commercialisation des produits vivriers ne fait l'objet d'aucune organisation. En fait, le dynamisme particulier dont fait preuve les petits commerçants dans ce domaine, rend très difficile l'intervention de l'Etat. En conséquence, le personnel d'encadrement agricole, n'assistant pas à la vente par le paysan de son maïs ou de son sorgho sur les marchés traditionnels, il ne peut procéder à la récupération des frais d'engrais correspondants. La solution de facilité adoptée, par les organismes chargés de la distribution d'intrants agricoles, a été d'exiger la vente au comptant. Nous avons déjà expliqué que cette disposition n'est pas opérationnelle, car le paysan n'a pas les moyens de payer son engrais au comptant.

La Distribution

Une insuffisance capitale relevée au niveau de la distribution, est le retard dans la mise en place des produits au niveau des villages. Cela est essentiellement dû au retard mis par la structure chargée de l'importation, à payer les fournisseurs. Ces derniers ne placent les produits en fabrication qu'après avoir reçu confirmation de l'établissement du crédit documentaire par leurs banques.

Les engrais sont donc livrés aux paysans à partir des mois d'avril (rarement) mai et juin (très souvent). La conséquence est qu'au Sud du pays, où la première saison des pluies commence au mois de mars pour le semis du maïs, l'engrais arrive toujours trop tard pour les cultures de première saison.

La Production

Deux problèmes essentiels retardent actuellement la mise en service de l'usine de reformulation d'engrais :

a) Le manque de moyens financiers :

Le fonds de roulement pour l'acquisition de matières premières et le financement du fonctionnement de l'usine fait gravement défaut à la société des engrais du Bénin, société d'Etat chargée de la gestion de l'usine.

Il a été plusieurs fois proposé que la SONAPRA, unique client de l'usine, avance les fonds nécessaires au démarrage des activités, comme il est le cas pour l'importation des engrais actuellement. Cependant, les bailleurs de fonds, en particulier la Banque Mondiale, se sont toujours opposés à cette solution, estimant que la fourniture des engrais par l'usine doit se situer dans le cadre de sa participation à l'appel d'offres, lancé chaque année.

b) le prix de revient :

Il apparaît que le prix de revient de l'engrais, formulé sur place, est supérieur à celui du même produit importé.Mais le gouvernement béninois a estimé qu'à l'intérieur du pays, les avantages de la formulation à savoir : la fourniture à temps, la régularité de l'approvisionnement, l'adaptation des formules d'engrais aux types de sol et aux différentes conditions écologiques justifient ce supplément de prix.

c) La valeur ajoutée :

La valeur ajoutée de la formulation est à peine de 10 % du prix de revient des matières premières. La Banque Mondiale estime que ce chiffre est insuffisant pour justifier l'implantation de l'usine et surtout pour permettre d'accorder la priorité à la production intérieure, même plus chère, dans le cadre des stocks qu'elle finance.

Pour la Banque Mondiale, les questions de prix de revient et de valeur ajoutée de 20 % sont intimement liées. Une valeur ajoutée de 20 % au moins peut justifier qu'une priorité soit accordée à la production nationale , même si elle est un peu plus chère ces problèmes, liés à la mise en oeuvre de la politique des engrais, appellent un certain nombre de mesures pour que les objectifs fixés soient approchés.

Les Mesures A Prendre

Comme nous l'avons vu, pour atteindre les objectifs d'autosuffisance et de sécurité alimentaire, l'augmentation de la productivité, liée à l'utilisation des engrais, se heurte à certaines contraintes qui limitent l'utilisation des engrais sur les cultures vivrières. Il convient donc qu'un certain nombre d'actions soient menées pour que la politique conçue, devienne une réalité.

L'extension de l'utilisation des engrais aux cultures vivrières nécessite que :

1. le personnel de vulgarisation se préoccupe, au niveau du paysan, de ses besoins d'engrais pour les cultures vivrières ; et que le personnel d'encadrement suscite l'utilisation des engrais sur les cultures vivrières, comme il est le cas pour les cultures d'exportation ;
2. les autorités acceptent l'extension du crédit des intrants aux cultures vivrières, afin de permettre aux agriculteurs de disposer des quantités nécessaires pour leur cultures ;
3. dans un premier temps, la recherche prescrit l'utilisation de types d'engrais simples actuellement connus, pour la fumure des cultures vivrières : urée supertriple, sulfate d'ammoniaque, phosphate d'ammoniaque, etc. Ces prescriptions doivent concerner les types d'engrais, les doses, les périodes, le mode d'épandage;
4. dans un deuxième temps, la recherche s'emploie à mettre au point, comme pour les cultures d'exportation, des formules complètes d'engrais pour les cultures vivrières, en vue de restaurer effectivement le niveau de fertilité des sols ;
5. le calendrier d'importation des engrais soit effectivement respecté pour permettre, dans la région du Sud, de disposer des produits pour les cultures de première saison, les cultures de céréales en particulier.

6. un système de commercialisation des produits vivriers, contrôlé par les organisations paysannes (groupement villageois, coopérative), soit conçu et mis en oeuvre, en vue de faciliter la récupération du crédit engrais sur vivriers ;
7. en ce qui concerne les financements des projets agricoles, les bailleurs de fonds soient amenés à inclure les crédits nécessaires à l'acquisition d'engrais pour les cultures vivrières ;
8. la mise en route de l'usine de reformulation d'engrais soit envisagée dans les délais les plus brefs pour éviter que cette infrastructure ne se détériore. Compte tenu de sa capacité, son utilisation peut être envisagée dans le cadre de la coopération sous-régionale. Les bailleurs de fonds devront être sensibles aux avantages de cette unité, afin qu'ils acceptent de financer son exploitation.

Principal Constraints to Fertilizer Use in Cameroon

Félix Nkonabang

Numerous constraints hamper fertilizer use in Cameroonian agriculture. Among these are cumbersome institutional arrangements with several overlapping ministries and agencies involved in fertilizer procurement, distribution, and marketing, resulting in delays and non-observance of the agricultural calendar.

The most serious constraints at this level include limited storage capacity at different points from the seaport to locations where most farmers receive their fertilizers, loss of fertilizers during transport and distribution, and poor management of the distribution and marketing systems. All these constraints result in high cost of fertilizers at the farm level. In addition, fertilizers and other imported inputs do not always conform to technical and agronomic specifications, which explains to a large extent why optimum yields are not obtained.

The estimation of fertilizer needs is made at the beginning of each crop season using a survey method in which a questionnaire is sent to different users. On the basis of the response, the volume of fertilizer to be imported is established for subsidized and non-subsidized sectors. In this process, no effort is made to take into account the production target and relate this target to the size of cultivated areas, recommended fertilizer applications, and crop- fertilizer price ratios. Moreover, research on fertilizer use is concentrated on export crops (coffee, banana, cacao, cotton, palm oil, and pineapple) where fertilizers are more profitable.

Due to limited government financial resources, the volume of fertilizer use remains small relative to potential demand. The government gives fertilizer subsidies directly to fertilizer importers, including the public agency involved in fertilizer delivery (Fonds National de Développement Rural: FONADER), and maintains uniform prices across the entire country. Fertilizer credit is distributed in areas without well-established cooperatives or development projects. In other areas, farmers are required to pay for their fertilizers in cash which is not always readily available. Regarding output pricing policy, it should be noted that the producer prices of export crops are fixed by the government, while those for food crops are determined by domestic supply and demand conditions.

The current strategy adopted by the Government of Cameroon in order to increase agricultural production relies heavily on area expansion, fertilizers, pesticides, and high-yielding varieties. Toward this end, the government has initiated a number of policy reforms, including liberalization of the fertilizer market and gradual reduction of subsidies. For these reforms to succeed, fertilizers and other modern inputs have to be made accessible to most farmers in a cost-effective manner.

Principales Contraintes A L'Utilisation Des Engrais Au Cameroun

Félix Nkonabang

L'Agriculture Dans L'Economie Du Cameroun

La majeure partie de la population du Cameroun (70 %) réside dans les zones rurales et vit principalement d'agriculture. L'économie camerounaise repose de ce fait sur le secteur agricole, qui, avec l'élevage, fournit au pays l'essentiel de ses revenus.

En effet, la contribution de l'agriculture au produit intérieur brut (PIB) et aux recettes d'exportation est respectivement de l'ordre de 30 à 70 %. Ce secteur compte plus d'un million d'exploitations agricoles et couvre près de 3 millions d'hectares, soit 20 % des terres agricoles potentielles.

Si le Cameroun, dans sa diversité, présente des sols particulièrement riches (volcaniques) dans la partie Ouest, il n'en est pas de même des autres régions où les terres sont de fertilité moyenne et où, du fait de la sédentarisation de la population, il s'avère de plus en plus nécessaire d'améliorer la fertilité de sols par des apports d'engrais si l'on veut augmenter la production alimentaire.

L'approvisionnement du secteur agricole en engrais rencontre de nombreux blocages. Nous allons examiner en détail les contraintes liées aussi bien à l'importation qu'à la distribution et à la commercialisation des engrais chimiques. Nous aborderons, ensuite, les problèmes relatifs à la demande, aux prix, aux crédits, à l'utilisation des inputs complémentaires, à la vulgarisation et à la recherche. En dernière analyse, nous exposerons la politique envisagée par le gouvernement en matière d'approvisionnement et de distribution des engrais.

Contraintes A L'Utilisation Des Engrais

Contraintes Structurelles liées à l'Importation des Engrais

L'acquisition des engrais destinés au secteur traditionnel de l'agriculture, au secteur encadré et aux coopératives, est soumise au système d'appel d'offres et au système de quota qui impliquent l'intervention de plusieurs administrations dont :

- le Ministère de l'Agriculture qui détermine les types, les quantités de produits et élabore le projet d'appel d'offres ;
- le Ministère des Marchés qui lance l'appel d'offres ;
- le Ministère des Finances qui met en place le financement ;
- la Commission Technique de Détermination des Inputs qui vérifie la qualité des produits ;
- la Commission Nationale des Marchés qui procède au dépouillement;
- la Commission d'Analyse qui analyse les offres et présente des propositions à la Commission Nationale des Marchés.

Cette multiplicité de circuits sous-entend la lourdeur et les autres carences inhérentes aux procédures administratives : (1) la mise en place du financement qui se fait toujours avec beaucoup de retard ; (2) la lenteur dans l'attribution des marchés à cause des conflits d'intérêt, des transactions de coulisse et des procédures précédemment mentionnées ; (3) le non respect du calendrier agricole, tributaire des saisons, de sorte que les engrais arrivent à contre saison et ne peuvent être utilisés avec efficacité, ce qui compromet l'effet escompté sur les rendements.

Contraintes Financières

L'acquisition des engrais est effectuée sur la base d'une subvention inscrite, chaque année, au budget d'Investissement Public (PIB) de l'Etat. Ceci signifie que les quantités d'engrais à acquérir sont tributaires de l'enveloppe financière et que l'Etat ne peut poursuivre qu'une politique correspondant à ses moyens. Il y a donc, nécessairement, une limitation quantitative des produits et, en conséquence, les besoins ne sont jamais totalement satisfaits, les normes techniques et agronomiques de ces inputs ne sont pas toujours respectées, aussi, les rendements optimaux ne sont-ils jamais atteints.

Les Problèmes de Distribution et de Commercialisation

Aux problèmes sus-évoqués liés à l'acquisition des inputs s'ajoutent ceux de la distribution dont les plus importants sont :

- la faible capacité de stockage, aussi bien du port de débarquement (Douala) qu'à celui du lieu d'utilisation à l'exception des coopératives de l'Ouest et des sociétés de développement ;
- la maîtrise insuffisante des techniques de gestion rendant les coûts excessivement élevés ;
- les pertes au niveau du transport et de la distribution ;
- etc...

Les Problèmes de Demande, de Prix et de Crédit

Les besoins ou la demande potentielle sont déterminés en début de campagne sur la base de sondages, par des circulaires adressées aux différents usagers s'approvisionnant par le biais du système d'engrais subventionné : services techniques, coopératives, sociétés de développement. Les réponses sont ensuite analysées et sur la base des résultats obtenus, les commandes sont passées en tenant compte d'une marge d'erreur.

La détermination des besoins devrait plutôt s'opérer sur la base des objectifs de production de chaque secteur (spéculation), en fonction des éléments suivants : les superficies, les doses recommandées pour les différents épandages, les rendements escomptés, le prix de revient ... Les besoins se déterminent-ils encore par un système de navigation à vue et en particulier en fonction des disponibilités financières ?

Pour la campagne 1987/1988, toutes formules confondues, les besoins ont ainsi été établis à 150.000 T pour le secteur subventionné, et à 50.000 T pour le secteur non subventionné, (Cf. tableau). Rappelons que l'offre d'engrais reste inférieure à la demande potentielle à cause du financement qui n'est pas toujours suffisant.

Absence de Crédit de Campagne

A l'exception des zones, où il existe des coopératives bien structurées (Nord-Ouest, Sud-Ouest, Ouest, Littoral) et des Sociétés de Développement (SEMTY, WADA, UNVDA,...), où un système de crédit pré-campagne est institué, les paysans des autres zones sont obligés d'acheter au comptant les engrais dont ils ont besoin. Or, il se trouve que les périodes d'épandage des engrais coïncident avec les périodes de soudure, où les paysans n'ont pas d'argent liquide et doivent donc faire appel aux usuriers et autres trafiquants de mauvaise foi.

Effets des Engrais sur les Rendements et Utilisation d'autres Types d'Amendements

Dans les conditions actuelles, les pratiques agricoles restent essentiellement traditionnelles et les engrais s'utilisent surtout pour les cultures d'exportation (café arabica et robusta, coton, riz, banane douce,...). Cependant, les cultures vivrières bénéficient des arrières effets de la fertilisation, du fait de l'association des cultures qui se trouve être la règle un peu partout dans le pays, à l'exception des provinces septentrionales où le mil et le sorgho sont cultivés essentiellement.

Bon nombre de petits paysans, surtout ceux du secteur maraîcher (Noun Obala, Maroua) utilisent beaucoup le compost. La fabrication des compostières occupe une place importante dans la formation des encadreurs et entre systématiquement dans les programmes de vulgarisation agricole.

Des travaux de recherche sur l'utilisation d'un certain nombre de formules d'engrais ont été entrepris par l'Institut de la Recherche Agronomique (IRA) sur certaines cultures principales du pays ; des doses optimales d'engrais ont été établies et recommandées. Le tableau ci-dessous résume les résultats de cet effort de recherche.

Café Robusta	700-900 kgs/ha	2,5 T/ha (café parche)
Café Arabica	700-900 kgs/ha	2,5-3 T/ha (café parche)
Banane d'exportation	700 kgs/ha	35 T/ha (café parche)
Ananas	500 kgs/ha	50-65 T/ha (café parche)
Riz	250-400 kgs/ha	4.500-5.000 kgs/ha
Coton		800-1.300 kgs/ha
Palmier à huile (régimes de noix de palme)	271-645 kgs/ha	30 T/ha
Canne à sucre	500-700 kgs/ha	84 T/ha

Comme nous pouvons le constater, les principaux résultats concernent uniquement les produits d'exportation. La consommation moyenne d'engrais reste dans l'ensemble faible, de l'ordre de 35 kgs/ha soit 150 kgs/ha pour les cultures d'exportation et 9 kgs/ha pour les cultures vivrières.

Par ailleurs, il convient de souligner que certains résultats de recherche sont encore peu connus des services de vulgarisation, à cause de la faible relation existant entre la recherche et la vulgarisation. Cette situation, fort préoccupante, a déjà fait l'objet de multiples rencontres, et il y a lieu d'espérer qu'une solution sera trouvée dans le cadre d'un projet de réformes du système de vulgarisation, dont l'exécution de la phase expérimentale démarrera bientôt.

Il faudrait enfin noter que la plupart des formulations concernent les engrais destinés aux cultures de rentes bénéficiant de subventions depuis 1973, alors que la subvention aux cultures vivrières ne date que de 1981.

Coûts et Bénéfices Liés à L'Utilisation Des Engrais

Engrais, Productivité et Revenus des Agriculteurs :

Si les engrais ont une incidence déterminante sur certaines productions d'exportation, (café, banane d'exportation, ananas, riz, palmier à huile, hévéa, etc...), ils n'ont par contre qu'un effet marginal sur les cultures vivrières, qui ne bénéficient que des effets résiduels dans la plupart des régions, où les cultures sont en association ou suivent un cycle d'assolement.

La faible utilisation des engrais dans la culture vivrière est principalement liée aux facteurs suivants :

- l'introduction tardive (1981) de la subvention qui n'était accordée que pour les cultures de café, car elle provenait de la caisse de stabilisation du café et du cacao. Cette subvention devait soutenir les revenus des agriculteurs en vue d'encourager l'utilisation des engrais pour l'accroissement de la production.
- le manque d'organisation du secteur de la production vivrière par rapport à celui des cultures d'exportation : il n'exsite ni coopératives, ni circuits de commercialisation et de crédit, donc absence de moyens de récupération.

  Dans l'ensemble, il s'ensuit que la productivité vivrière reste faible et réduit le revenu de ses agriculteurs.

  Une action efficace devrait donc être envisagée pour la vulgarisation de l'usage des engrais sur les cultures vivrières. Cette action devra être centrée sur :
  - l'organisation et la mise en place d'un programme de démonstration et de formation des paysans, avec affectation d'encadreurs dans les zones, où l'usage des fertilisants est peu ou pas connu (Est, Adamaoua, Extrême Nord, Sud et Centre...) ;
  - l'organisation du circuit de commercialisation avec structuration du milieu socio-professionnel, la création de groupements coopératifs, la mise en place d'un système de crédit, etc...

La Subvention aux Engrais :

Le terme "subvention" désigne généralement l'assistance financière accordée par le Gouvernement à une personne, à une collectivité, à une société ou à une organisation, dans le but de faciliter certaines acquisitions de biens ou de services.

La subvention aux engrais, en pratique courante au Cameroun, est payée aux fournisseurs/importateurs et à l'agence publique (Fonds National de Développement Rural : FONADER), chargée du transport et de la distribution.

Il s'agit donc d'une subvention directe et inconditionnelle, car elle concerne tous les types d'engrais utilisés pour toutes les cultures sans exception.

Dans ces conditions, les prix uniformes/uniques sont fixés par le gouvernement et sont appliqués à toutes les régions camerounaises.

En dehors de cette subvention, d'autres avantages ou traitements préférentiels sont accordés aux importateurs : il s'agit, en particulier, de l'exemption des droits de douane, l'application de tarifs préférentiels pour les droits portuaires, etc...

A titre d'exemple, le tableau 1 indique, pour les années 1985/1986, 1986/1987 et 1987/1988, les prix des différents produits (engrais) vendus à Douala et les prix subventionnés qui furent pratiqués.

La subvention aux engrais a été introduite comme une source déguisée d'investissements dans le secteur de la production caféière (le secteur cacaoyer, lui, bénéficiant de la gratuité des produits de traitement phytosanitaire).

La présence de cette subvention semble justifier le faible niveau des prix des produits de base, comparativement au coût de production. Il en résulte un faible niveau des revenus aux producteurs paysans, un faible pouvoir d'achat étendu à la majorité de la population et, par conséquent, une faiblesse de l'économie nationale.

Soutien des Prix Agricoles :

Les prix des produits d'exportation ne sont pas subventionnés et ils restent dans l'ensemble assez faibles par rapport au coût de production. Néanmoins, ils sont soutenus grâce à la caisse de stabilisation, dont l'action est certainement déterminante pour le maintien du niveau des revenus aux planteurs, sans pour autant résoudre le problème du coût de production, ni celui de la détérioration des termes de l'échange.

Les produits vivriers ne sont pas soutenus et la fixation des prix s'opère par le jeu de l'équilibre entre l'offre et la demande. Ces prix subissent des fluctuations saisonnières liées au cycle de production . Bien qu'il existe, sur la base d'une "mercuriale" des "prix homologués", fixés par les autorités administratives de chaque province pour les produits courants, et par l'administration centrale pour les produits de grande consommation (sucre, riz, huile) la concurrence, surtout, joue un rôle important.

D'autres facteurs influant sur le secteur des produits vivriers sont :

(1) l'absence de technologie dans le domaine de la transformation et de la conservation : la détérioration rapide de certains produits entraîne des pertes considérables.

(2) l'absence de maîtrise des technologies susceptibles d'améliorer la productivité tant dans le secteur traditionnel que dans celui des agro-industries : la faible productivité des rendements entraîne des coûts de production élevés et, par conséquent, des prix de vente accrus. La concurrence devient alors difficile à soutenir vis-à-vis des produits importés (riz, huile, sucre, farine) provenant des pays qui maîtrisent parfaitement les technologies de production et qui, de plus, consacrent des subventions importantes à l'exportation de ces produits.

Tableau 1. **Evolution Du Prix Des Engrais Depuis 1985. (Fob Douala) Et De La Subvention Depuis 1985**

Types d'engrais	1985/86		1986/87		1987/88	
	Prix Fob Douala	Prix sub.	Prix Fob Douala	Prix sub.	Prix Fob Douala	Prix sub.
20-10-10	93 054 F/T	35 000 F pour enlèvement à Douala et 40 000 F dans les autres provinces	72 000	35 000 F pour enlèvement à Douala et 40 000 pour les autres provinces	65 860	Encore non fixés
12-6-20	86 000		69 0000		65 095	
10-20-10	-		74 000		69 350	
Sulfate d'Am. 21% M	59 065		48 000		39 950	
UREE 46% N	69 000		55 000		52 500	

N.B.: Au prix FOB DOUALA s'ajoutent les frais suivants qui étaient supportés par l'Etat:

- Frais de stockage, protection, reconditionnement et autres: 7 à 9 000 F/T.
- Frais de transport 28 à 39 F/T/Kg, soit en moyenne nationale pondérée.
- Frais de distribution 10 000 F/T en moyenne
- Marge de distribution 0 à 6 000 F/T suivant organismes.
- Marge d'erreur 0 à 6 000 F/T suivant organismes.

Politique Agricole Et Réforme Du Sous Secteur Engrais

Grande Lignes de la Politique Agricole

La politique agricole du Cameroun vise à consolider l'autosuffisance alimentaire, malgré quelques déséquilibres, qui peuvent subsister ou subvenir dans certaines régions du pays.

Cette politique vise également à développer la production agricole en vue d'approvisionner les pays limitrophes et voisins, et de pourvoir les secteurs secondaires et tertiaires, constituant les principaux fournisseurs en matières premières de l'agriculture et des populations agricoles, principales consommatrices de biens et de services.

Compte tenu du rôle fondamental de l'agriculture dans l'économie du pays, le Gouvernement camerounais attache une attention toute particulière au développement de l'agriculture, en général, et à celui des engrais en particulier. Pour ce faire, trois principales mesures sont envisagées visant l'accroissement de la production agricole, à savoir : l'extension des superficies cultivables, l'intensification de la mécanisation et des programmes d'accompagnement, utilisation des engrais, de la fumure et d'autres intrants complémentaires, (semences améliorées), et la continuité de la lutte phytosanitaire.

Réforme du Sous-Secteur Engrais :

Le principal objectif est l'intensification de l'utilisation des engrais, étant donné que ce facteur de production contribue pour plus de 50 % à l'accroissement des rendements. Or, malgré les besoins importants et la capacité élevée de consommation des producteurs, surtout pour les zones de Café Arabica à l'Ouest et au Nord-Ouest, il n'est pas toujours possible de satisfaire les demandes en engrais, les acquisitions de ces intrants étant limitées par les disponibilités de financement, liées aux subventions de l'Etat.

Face à cette situation, le Gouvernement a mis en oeuvre, avec l'assistance technique et financière du Gouvernement des Etats-Unis (USAID), un programme de réformes du Sous-Secteur Engrais, dont les principaux objectifs portent sur la libéralisation du marché de ces produits, par la privatisation des circuits d'acquisition et de distribution, avec un transfert intégral, mais progressif, des fonctions de commercialisation des institutions publiques (FONADER) à un système libéral qui, parallèlement à son bénéfice, aidera à l'augmentation de l'utilisation des engrais au coût le plus bas possible.

Cela devrait avoir pour effet l'élimination progressive des subventions et donc d'une économie de devises, la simplification des procédures d'acquisition des engrais et, en conséquence, le respect des délais de leur mise à disposition et du calendrier agricole. (Cf. tableau 2). Ces mesures seront naturellement renforcées par la promotion de l'utilisation des engrais grâce à des programmes de sensibilisation, à l'utilisation d'un réseau de détaillants à tous les niveaux, et surtout grâce aux bénéfices qu'en tirent les paysans. A la long terme, cette politique conférera à l'exploitant agricole l'entière responsabilité de la gestion de son exploitation et l'incitera à l'épargne en vue investissements réguliers au sujet desquels il aura appris à saisir le sens et l'objectif.

Tableau 2. **Evolution De La Consommation D'Engrais Subventionnés Pour La Période 1990/1988**

Années	Consommation en tonnes	Valeur en FCFA
1980-1981	44.000	3.500.000.000
1981-1982	52.000	3.500.000.000
1982-1983	85.000	6.000.000.000
1983-1984	82.326	7.000.000.000
1984-1985	65.313	6.500.000.000
1985-1986	75.000	6.500.000.000
1986-1987	110.000[1]	7.000.000.000
1987-1988	60.000[2]	4.000.000.000

[1]Marchés encore en cours d'exécution, déjà livrées : 64.983 tonnes.

[2]Prévisions de l'exercice en cours.

En tout état de cause, la solution aux problèmes du marché des engrais et à la subvention constitue la toile de fond de la stratégie, progressivement mise en place depuis septembre 1987, date de la signature de la convention d'assistance avec l'USAID. Les principales composantes de cette stratégie sont :

- la fixation des prix aux consommateurs (bas prix des engrais et des produits agricoles ou prix élevés des engrais et des produits agricoles) ;
- la suppression totale ou partielle de la subvention avec, pour corollaire, l'introduction des mesures de compensation telles que les prix incitatifs, les investissements sociaux, etc...

Toutes ces mesures auxquelles s'ajouteront bien d'autres telles que la réduction de taux d'intérêts (taux préférentiels) pour les crédits octroyés aux fournisseurs, la mise en place d'un système de crédit de campagne aux agriculteurs, etc... devraient permettre, nous l'espérons, d'assurer aux agriculteurs, au bon moment et au bon endroit, la fourniture à un prix compétitif des engrais les plus adaptés à leurs besoins, ce qui suppose un excellent circuit de commercialisation, de transport et de distribution, des facilités de stockage et des services d'encadrement efficaces. Elles devraient également permettre aux agriculteurs de produire et de vendre mieux, plus, de rentabiliser ainsi leurs efforts et d'augmenter leurs revenus grâce à l'utilisation rationnelle des engrais, constituant les principaux catalyseurs dans une agriculture appelée à se moderniser pour devenir plus performante et plus compétitive.

Conclusion

En résumé, nous pouvons noter que les principaux facteurs, étant à l'origine de la sous-consommation des engrais, sont dus au fait que les petits agriculteurs, constituant la principale force de production dans un système où le secteur

traditionnel domine, reçoivent peu ou pas d'engrais pour les raisons suivantes : faible disponibilité des fertilisants, prix élevés des engrais, méconnaissance de la rentabilité des engrais, manque de liquidités et absence de crédits.

Pour un pays comme le Cameroun, où l'objectif majeur porte désormais sur l'accroissement des rendements et de la productivité agricole, nous restons convaincus que si l'atteinte de ces objectifs passe par différentes voies (l'extension des superficies cultivées, la mécanisation du secteur moderne, la modernisation de la production agricole par la création d'exploitations agricoles de moyenne importance, la baisse de la moyenne d'âge des agriculteurs, la restructuration de l'encadrement, l'utilisation des intrants appropriés etc. . .), elle passe surtout par l'accroissement de la consommation des engrais et, en d'autres termes, par le déblocage des différents goulots d'étranglement dont quelques-uns ont été analysés ci-dessus.

Par ailleurs, le Cameroun a besoin d'une croissance économique soutenue dont l'agriculture est le principal moteur. Pour soutenir et revitaliser ce secteur clé de l'économie, le Gouvernement doit absolument développer l'emploi intensif des engrais, accroître leur efficacité tout en limitant les sorties de devises dûes aux subventions.

Le programme de réforme du sous-secteur des engrais, dont la mise en place est imminente et dont les principaux objectifs portent sur la libéralisation des importations, et de la distribution des engrais et sur la suppression à terme de la subvention, devrait contribuer à la promotion de la consommation des engrais.

Cependant, nous pensons que, parallèlement à ce programme, d'autres voies doivent être recherchées et devront porter sur la diminution des coûts dans ce secteur, l'incitation à la consommation des engrais, l'amélioration du niveau de revenu des paysans, et la production nationale des engrais, qui, seule, permettra des économies de devises et contribuera à une certaine indépendance nationale.

The Fertilizer Sector in Côte D'Ivoire

Kouame Koffi

Of the 10.1 million people living in Côte d'Ivoire, 67% reside in rural areas. Agriculture is the dominant economic activity. It provides 25% of GDP and 60% of export revenue. About 80% of the labor force is engaged in agricultural activities. Taxes on agricultural exports provide 30% of the annual government budget.

Agricultural output comes mainly from small farms and plantations or agro-industries. The small-farm sector is characterized by traditional methods of production. This sector produces the bulk of food crops and most of the coffee and cacao. Some small farms use modern agricultural techniques, for example, those in irrigated rice projects where fertilizers are provided at no cost by the government. Plantation agriculture is dominated by big corporations using advanced agricultural technologies. The use of fertilizers is common, and these corporations work closely with research centers. They also assist farmers in the development of plantations known as *plantations villageoises*.

To promote the development of the economy, the Ivoirian government has implemented policies that favor agricultural diversification, modernization, and improved productivity. The country's fertilizer needs are largely covered by SIVENG (Société Ivoirienne d'Engrais), which also exports to Mali and Burkina Faso. Other fertilizers, such as urea and potassium, are imported by two private companies, STEPC (Société Tropicale d'Engrais et de Produits Chimiques), and Agricentre. These imports are made through tenders. This helps maintain price uniformity between the local and international levels.

Until recently, fertilizer prices were subsidized. This practice has now been eliminated. The government has also imposed a tax on fertilizer imports since 1987 to protect SIVENG and has implemented compensatory measures to neutralize the tax impact. It is important to note, however, that a significant number of farms do not use fertilizers at all.

Le Secteur Des Engrais En Côte D'Ivoire

Kouame Koffi

Introduction

Aperçu Général sur la Côte d'Ivoire

La Côte d'Ivoire est située entre le 5ème et le 11ème degré de latitude Nord et le 3ème et le 9ème degré de longitude Ouest.

Elle est limitée au Nord par les républiques du Mali et du Burkina Faso, à l'Ouest par les républiques de Guinée et du Libéria, à l'Est par la république du Ghana. Elle est bordée au Sud par l'Océan Atlantique. Sa superficie est de 322 462 km2.

Deux climats se partagent le territoire ivoirien :

- le climat subéquatorial ou "attiéen", touchant les régions comprises entre la côte et le 9ème parallèle, qui comporte quatre saisons : deux saisons pluvieuses (de mi-mars à juillet et d'octobre à novembre) et deux saisons sèches (de décembre à mars et d'août à septembre) ;
- le climat "soudano-guinéen" ou climat tropical humide, affectant les régions situées au Nord du 9ème parallèle, qui est caractérisé par deux saisons : une saison pluvieuse de 6 à 7 mois et une saison sèche de 5 à 6 mois.

A ces grandes divisions climatiques correspondent deux grands types de végétation : les savanes au Nord et la forêt au Sud.

Quant à la population de la Côte d'Ivoire, elle est de l'ordre de 10.100.000 habitants (chiffre de 1984). Cette population est en majorité rurale, soit plus de 67 %. Le taux de croissance de la population ivoirienne se situe à 4 % par an.

Les Données Economiques

L'économie de la Côte d'Ivoire est dominée par l'agriculture qui reste le moteur du développement économique et social du pays. Les productions agricoles procurent à l'Etat et aux populations l'essentiel de leurs revenus. L'agriculture fournit environ 25 % du PIB et plus de 60 % du total des exportations de marchandises. Elle emploie près de 80 % de la population active et les taxes sur les cultures d'exportation représentent 30 % des recettes publiques annuelles.

Pour consolider et développer l'économie nationale, la Côte d'Ivoire a mis en place une politique qui privilégie la diversification de l'agriculture. Afin de promouvoir ce secteur vital pour la croissance économique du pays, le gouvernement a mis en oeuvre une stratégie orientée vers les points suivants : l'utilisation des jachères pour lutter contre l'exploitation abusive de notre patrimoine forestier, la modernisation de l'agriculture par l'installation des jeunes agriculteurs, l'amélioration de la productivité.

Cette nouvelle agriculture suppose donc l'adoption des techniques agricoles modernes et une utilisation accrue des intrants de production, en particulier, pour le cas de l'engrais.

Fourniture Des Engrais

La Production Domestique d'Engrais

La production domestique d'engrais est assurée par la SIVENG (Société Ivoirienne d'Engrais), société d'économie mixte, à participation de l'Etat, créée en 1965. La capacité nominale de la SIVENG était de 60.000 T pour couvrir les besoins ivoiriens en engrais composés. Vers les années 1970, la consommation locale avait atteint 70.000 T, ce qui avait entraîné le doublement de la capacité de production qui était passée à 120.000 T pour tenir compte des exportations vers le Mali et le Burkina Faso. Actuellement, la consommation intérieure a baissé et se situe à 50.000 T ; la production annuelle de la SIVENG, à l'heure actuelle, se situe entre 75.000 et 80.000 T dont 50.000 T pour la consommation locale et 25.000 à 30.000 T pour les exportations vers le Mali et le Burkina Faso.

Les Importations d'Engrais

Les importations d'engrais sont assurées par deux sociétés privées : STEPC (Société Tropicale d'Engrais et de Produits Chimiques) et AGRICENTRE.

Les engrais importés sont les engrais simples tels que l'urée, le chlorure de potassium, le sulfate de potassium, le phosphate tricalcique, le kiesérite. Pour satisfaire leurs besoins en engrais, la Palmindustrie et la Sodesucre procèdent par appels d'offres internationaux.

Au niveau des importations, il apparaît très difficile d'obtenir des chiffres estimatifs des quantités importées.

La Politique du Gouvernement

Jusqu'à une date très récente, les prix des engrais étaient subventionnés par le gouvernement sous forme de paiements, établissant la différence entre le prix de revient et le prix de cession aux paysans ; cependant, cette subvention a été supprimée. Afin de protéger la SIVENG, société locale productrice d'engrais, et dans le but d'atténuer l'incidence de cette taxe sur le secteur agricole, le gouvernement a imposé des taxes à l'importation des engrais depuis 1987 et a pris des mesures compensatoires qui tendraient à neutraliser l'effet de la taxe.

L'Utilisation Des Engrais

On distingue en Côte d'Ivoire deux grands types d'agriculture correspondant à deux types de production :

- les productions vivrières destinées à la subsistance des populations locales et basées sur des pratiques traditionnelles : le secteur des petites exploitations ;

- Les productions industrielles, destinées à l'exportation ou à la transformation industrielle, et basée sur les pratiques modernes les plus avancées : le secteur des agro-industries.

Le Secteur des Petites Exploitations

Le secteur des petites exploitations fournit la plupart des produits vivriers et produit la majeure partie du café et du cacao (qui couvrent environ 2.700.000 ha) pour le marché d'exportation.Les cultures sont souvent pratiquées sur de petites superficies et selon des méthodes traditionnelles, et sont souvent associées à la même parcelle. Il y a cependant quelques projets importants de développement agricole, qui sont basés sur les petites exploitations tout en utilisant une technologie moderne, c'est le cas des projets de riz irrigué.

Entre autre, ce secteur si vaste et si important, comprenant les cultures de riz, de manioc, d'igname, de plantain, de café et de cacao, n'utilise pas d'engrais. Les sols, en Côte d'Ivoire, sont pourtant relativement pauvres, toutefois, avec les défrichements de forêts vierges, les longues périodes de jachères, l'utilisation des résidus des récoltes et le bon entretien des parcelles, un taux stable mais faible de production est maintenu sans avoir recours aux engrais. Il faut signaler que dans ce secteur, seul le riz irrigué bénéficie de l'utilisation des engrais qui, en fait, sont gratuitement offerts aux paysans par le gouvernement.

Le Secteur des Agro-Industries

Il s'agit de la culture à grande échelle, utilisant souvent les pratiques agronomiques modernes les plus avancées, du palmier à huile, du cocotier, de l'hévéa, de la canne à sucre, de la banane, de l'ananas et du coton. Ces grandes plantations sont l'oeuvre de puissantes sociétés d'état d'économie mixte ou de sociétés privées, c'est le cas, par exemple, de :

- PALMINDUSTRIE pour le palmier à huile et le cocotier.
- SAPH (Société Africaine des Plantations d'Hévéa) et SOGB (Société de Grand Bereby) pour l'hévéa.
- SALCI pour l'ananas.
- SODESUCRE pour le sucre.
- CIDT (Compagnie Ivoirienne pour le Développement des Textiles) pour le coton.

A côté des plantations industrielles qu'elles exploitent, ces sociétés encadrent les paysans pour la réalisation de plantations dites "villageoises".

Ici, l'utilisation des engrais est de règle et s'effectue conformément à des normes agronomiques généralement exactes quant aux types d'engrais et aux doses d'application. En effet, ces sociétés travaillent en étroite collaboration avec des instituts de recherche. En général, les programmes d'engrais sont établis à partir d'analyses de sols, de tissus de plantes réalisées soit par ces sociétés, soit par les instituts de recherche.

Le Financement et la Distribution des Intrants aux Paysans

Considérant le pouvoir d'achat très limité de la population paysanne et son organisation, qui n'est pas tout à fait au point, en principe, ce sont les sociétés d'encadrement qui assurent le financement et la distribution des intrants (engrais, pesticides, herbicides,. . .).

a) Le financement et la distribution des intrants par les sociétés d'Etats et d'économie mixte. Ces sociétés achètent les intrants et approvisionnent leurs magasins régionaux afin d'assurer la distribution des produits auprès des paysans. Elles maîtrisent toute la filière de leurs productions agricoles et entrent, ainsi, dans leurs fonds au moment de la commercialisation. L'exemple de financement et de distribution le plus réussi est celui de la CIDT. En effet, la CIDT maîtrise toute la filière du coton : tout passe par elle (le paysan ne peut vendre son coton qu'à la CIDT). C'est ce qui explique les résultats très intéressants obtenus pour la production cotonnière.

b) Le financement et la distribution des intrants par les Etablissements Publics Nationaux (EPN)
Les EPN sont des sociétés d'encadrement des paysans (en général, elles ne produisent pas elles-mêmes). C'est le cas, par exemple, de la SATMACI (Société d'Assistance Technique pour la Modernisation de l'Agriculture de la Côte d'Ivoire) qui encadre les producteurs de café, de cacao, de riz et de maïs, et de la SODEPALM (Société pour le Développement et l'Exploitation du Palmier à Huile) qui encadre surtout les cultivateurs de riz et de maïs. Ces sociétés d'encadrement n'ont pas de trésorerie et ne peuvent donc pas servir d'intermédiaires entre les fournisseurs et les paysans, n'étant pas assez organisés eux-mêmes. Elles préparent les dossiers de crédit pour les paysans auprès de la BNDA (Banque Nationale pour le Développement Agricole) en vue de faciliter les démarches à l'acquisition des intrants. Cependant, étant donné que la SATMACI et la SODEPALM ne maîtrisent pas la commercialisation des produits agricoles, (les paysans vendent eux-mêmes leurs produits en suivant soit la filière officielle, soit la filière parallèle), la BNDA se trouve non-remboursée et, par conséquent, ne bénéficie d'aucun profit. Ainsi, la banque n'accorde plus de prêts aux paysans qui, de ce fait, n'ont plus accès aux engrais.

Le Prix des Engrais

La vente de la plupart des engrais s'effectue sur appels d'offres internationaux. Les sociétés nationales de production et de distribution d'engrais (SIVENG et STEPC) répondent à ces appels, entraînant ainsi une égalité du prix de vente de l'engrais sur le marché local au prix du marché international.

En général, quand les prix des engrais augmentent, la demande chute immédiatement ; cependant depuis la suppression de la subvention, nous n'avons pas encore constaté d'effets négatifs sur la demande. En effet, la CIDT, le plus important des clients de la SIVENG, n'a pas encore modifié sa demande, toujours restée autour de 40.000 T.

Conclusion

Vu les grandes superficies occupées par les exploitations agricoles (café, cacao et cultures vivrières) bénéficiant pas de l'utilisation des engrais, nous pouvons affirmer que la Côte d'Ivoire dispose d'énormes potentialités de développement concernant le secteur des engrais. Un tel développement est nécessaire pour améliorer la productivité de l'agriculture et suffire ainsi aux besoins de consommation de la population locale.

Le gouvernement doit donc mettre en place des dispositifs permettant aux paysans de payer les intrants. Pour cela, il faut redéfinir de nouvelles stratégies de commercialisation des produits agricoles, accroître le rôle des groupements à vocation coopérative (GVC), redéfinir leur statut afin pour les rendre plus crédibles. Ces GVC, assurant la commercialisation, pourront alors avoir accès aux crédits pour leurs membres.

Le Rôle Des Engrais Dans le Développement de la Productivité Agricole au Ghana

S. K. Dapaah et E. S. Otinkorang

Résumé

La politique agricole du Ghana vise à: (1) promouvoir la productivité des petits exploitants, (2) fournir à tous les Ghanéens une alimentation équilibrée, (3) équilibrer la balance des paiements à travers une diversification des exportations, et (4) établir des rapports réciproques entre l'agriculture et l'industrie.

En 1983, le gouvernement du "Provisional National Defense Council" et le Fonds monétaire international se sont mis d'accord sur un programme à court terme de stabilisation monétaire. Ce programme implique l'ajustement progressif des taux de change et un resserrement fiscal accru.

Quatre-vingt pour cent de la production agricole est assurée par les petits exploitants dont le niveau de productivité est très bas, parce qu'ils utilisent peu d'intrants, les engrais en particulier. Tous les problèmes que connaît le secteur des engrais se posent au niveau de l'importation et de la distribution. A cause de la rareté des devises et de la subvention aux engrais, le ministère de l'Agriculture se charge de l'évaluation des besoins annuels, de l'importation et de la distribution. Aucune unité de production locale n'existe au Ghana. Les produits importés sont ensuite répartis dans les régions suivant les besoins, et compte tenu des schémas habituels d'utilisation et du niveau des stocks.

Auparavant, l'importation, le transport et la distribution des engrais accusaient souvent des retards.

Les engrais ensachés sont importés par le port de Tema, mais les mauvaises conditions de fonctionnement de ce port limitent le taux de déchargement. Les engrais sont acheminés vers les dépôts intérieurs principalement par la route. Mais le réseau routier est généralement défectueux et le transport par chemin de fer ou par voie fluviale est peu développé. Ces facteurs expliquent en partie pourquoi environ dix pour cent à quinze pour cent seulement des utilisateurs potentiels ont accès aux engrais.

Selon les prévisions, la demande d'engrais qui se situait autour de 78 000 tonnes en 1988 passerait à 100 000 tonnes en 1989 et pourrait atteindre 107 000 tonnes en 1990. La demande est déterminée par le prix de vente des engrais que l'Etat subventionne à près de 42 pour cent. Le gouvernement projette de réduire progressivement cette subvention au cours des trois prochaines années, et de la supprimer vers 1990.

La privatisation du secteur des engrais au Ghana s'étalera sur une période de quatre ans – 1987-1990. La suppression de la subvention se fera à ce même rythme, ainsi que l'instauration du marché libre.

The Place of Fertilizer in Ghana's Quest for Increased Agricultural Productivity

S. K. Dapaah and E. S. Otinkorang

Introduction and Background

Agriculture, including forestry, has in the past accounted for about 55% of the gross domestic product (GDP) and close to 80% of merchandise exports; it has employed 55% of the labor force. About 70% of the population (9.2 million) live in rural areas. In every respect, therefore, agriculture is the "prime-mover" of the Ghanaian economy, and it is in the agricultural sector that the battle for long-term economic growth and development will be won or lost.

The scope for efficient growth in agriculture is great because Ghana is endowed with an immense agricultural resource base, a relatively large and potentially competitive industrial capacity, an abundant supply of hydroelectric power (1070 megawatts), a relatively well developed human capital base, and a relatively small population (13.2 million in 1987).

The development of Ghana into a solid agricultural nation that is capable of feeding herself and exporting her surpluses has in the past suffered as a result of a general decline in Ghana's economy. The GDP declined by 0.5% per annum between 1970 and 1982. Real per capita income fell by 30%, import volumes fell by 65%, and real export earnings declined by 52%, falling from 21% of GDP in 1970 to 4% in 1982. The consumer price index increased by 80% per annum between 1975 and 1982 and by 122% in 1983. The population growth rate, on the other hand, averaged 2.6% per annum between 1970 and 1984. The population in 1987 was 13.2 million, and the per capita gross national product (GNP) was about US $390 in 1985.

The general decline in the Ghanaian economy was caused, in part, by inappropriate and uncoordinated economic policies, outmoded institutions, and unworkable procedures. The inappropriate policies included (1) the maintenance of a grossly overvalued domestic currency rate; (2) quantitative import restrictions, which protected noncompetitive systems of industrial and agricultural production; (3) excessive taxation of exports, which resulted in reduced production and foreign exchange earnings; (4) maintenance of low product prices through subsidies for the benefit of urban consumers, which resulted in a marked decrease in domestic production; and (5) the uncoordinated fashion in which research, extension, and other institutions pursued their narrowly defined objectives.

Because of these unfavorable domestic policies and the consequent disincentives to produce the crops for which Ghana has a clear comparative advantage, there has been a decrease in the production of several crops, including tobacco, cocoa, cotton, rubber, and oil palm. The resultant highly distorted incentive structure has imposed high implicit taxation on some crops with a clear comparative disadvantage (merchandized rice and sugarcane).

Agricultural Policy Objectives

In recognition of the leading role that agriculture plays in the national economy, Ghana's agricultural policy is formulated to be a sub-set of national economic growth policies that are concerned with the attainment of such broad economic and social goals as *increased efficiency and productivity, internal price stability, external balance of payments, and political stability*.

Ghana's agricultural policy is to evolve a national agricultural strategy that is oriented toward development, enhanced productivity, and the promotion of competition. More specifically, the strategy would achieve the following goals:

1. Promote increased smallholder productivity and ensure that all efficient farmers, fishermen, processors, and distributors as well as others in the agricultural sector earn incomes that are comparable to those outside agriculture, thus making agriculture an attractive employment alternative to industry, trade, and commerce.

2. Provide all Ghanaians with adequate and nutritionally balanced diets at reasonable prices both now and in the future.

3. Ensure that agriculture contributes effectively to the country's balance of payments position through export diversification.

4. Establish effective linkages between agriculture and industry so that agriculture provides raw materials for industry while industry provides inputs to agriculture. The growth of agriculture will also create demand for industrial goods as the incomes of the farmers improve from increased productivity and marketable supply.

The principal objectives of agricultural policy during the second phase of the Economic Recovery Program (ERP) are as follows:

1. Liberalize the mechanisms for determining agricultural prices and imports, thereby promoting more competitive markets and more efficient resource allocation within agriculture.

2. Reduce and where possible eliminate dependence on imported food and industrial crops, fish, and livestock products for which Ghana has a comparative advantage.

3. Increase export earnings from crops and animal products, including cocoa and nontraditional exports.

4. Rationalize and improve the performance of public sector expenditure in agriculture.

5. Provide for sufficient research, incentive, and investment to ensure the implementation of national conservation policy.

6. Through the attainment of the above objectives, improve the producers' incomes, with particular attention to smallholders.

The Government's strategy for the rehabilitation and further development of the agricultural sector is based on considerations of competitiveness, efficiency, and equity. The Government's role in the sector will be rationalized to provide a suitable environment for competitive markets to develop and resources to be allocated efficiently. In order to achieve these objectives, the Government will identify and take appropriate steps to remove bottlenecks that continue to prevent farmers, fishermen, processors, and distributors from taking full advantage of the improved macroeconomic climate on their own accord.

Recent Policy Measures

Given the continuing decline of the economy, it was necessary to take appropriate trade, exchange rate, monetary, fiscal, and non-price policy initiatives. The Government of the Provisional National Defence Council (PNDC), which took office at the end of 1981, announced a series of fundamental economic reform measures in April 1983 and agreed to a short-term stabilization program with the International Monetary Fund (IMF). The major measures under this first phase of the ERP have included the following.

- Progressive exchange rate adjustments from C275 = US $1.00 in April 1983 to C185 = US $1.00 in March 1988. The latest exchange rate represents an auction rate.

- An increase in cocoa producer prices from C12,000 per tonne in April 1983 to C56,000 per tonne for the 1985/86 mid-crop year and C140,000 for 1986/87.

- An additional C10,000 per tonne to be paid if the production target for the 1987/88 season of 230,000 tonnes was exceeded.

- Increased fiscal stringency including substantial repayment by Government to the banking system.

- The preparation and implementation of rehabilitation programs for key sectors, including cocoa, gold, timber, mining, and transportation.

- Increases in low public sector salaries by 40% in April 1984 and 80% in January 1985 and by a doubling of salary levels on average in January 1987, with the objective of providing increased incentives in the civil service, particularly for the higher management levels.

- The encouragement of private sector involvement in activities previously controlled by Government and parastatals.

- Increasing interest rates to encourage saving and achieve a positive real rate of interest.

Recent figures show that the economy has begun to respond, despite a slow start due to severe drought in 1983. Real GDP increased by 10.7% in 1984, helped by a more normal rainfall, after five successive years of decline. A further increase of 5.1% in GDP was recorded in 1985 bringing the GDP to only 5% (in real terms) below the production peak that occurred in 1974. The increase in the consumer price index fell from 263% in 1983 to 40% in 1984, and a further decline to 10.4% occurred in 1985 despite heavy exchange rate adjustments. It rose to 25% in 1986 and to 35% in 1987. The balance of payments registered a US $215 million current account deficit in 1984. This was 2.8% of GDP, and it was slightly lower than the deficit of US $230 million in 1983. Total debt service (including IMF) was about US $281 million in 1985, which was 43.5% of estimated export levels in that year, which amounted to US $391 million in 1986.

Agricultural output, accelerated by good rainfall, improved incentives, and input supplies, grew at 10% in 1984 and accounted for about 51% of GDP. Further growth in agriculture was about 4% in 1985 and 2.5% in 1986.

Despite some positive responses to the policy reforms, the country still faces the formidable task of achieving food self-sufficiency and realizing the considerable potential for export. This is because the productivity of smallholders, who account for nearly 80% of agricultural production, is very low even for levels achieved in other African countries. The low productivity is largely attributable to the limited use of inputs (particularly fertilizer), low availability of credit for purchase of inputs, and weak infrastructure. The Government intervention is a major contributing factor since the budget allocates little for the mobility of nearly 5,000 extension agents (90% of the budget goes for their salaries), and the import of fertilizer and the purchase of seed by Government are almost always delayed because of the nonavailability of local funds and bureaucratic bottlenecks. The fertilizer for 1988 is still to be received, and the Ghana Seed Company, a state owned enterprise, cannot mobilize C50 million for purchase of seed for the ensuing season. Ghana depends on food aid and commercial imports for about 15% of its needs. In 1987, when the rainfall was late, the deficit in food grains was accentuated, resulting not only in larger imports but also in a steep rise in food prices; in turn, a highly inflationary situation developed, which had an adverse impact on the macroeconomic situation.

Farming Systems and Cropping Across Ghana

Ghana can be divided into four ecological zones, namely, coastal savannah, forest, transition, and northern savannah. These zones are fairly homogeneous for rainfall pattern and for agronomic and vegetation conditions, other factors that influence farming systems and input utilization.

The **transition zone** is considered overall as the main cereal food-crop area. It is just about 180,000 ha, and maize, the principal cereal in Ghana and possibly the first beneficiary of the fertilizers, is cultivated here. From a survey conducted in Brong-Ahafo Region (four districts) and confirmed by an informal survey in Ashanti Region, (Ejura district), it has been established that this cereal is the most important source of income for 80% of the farmers. Fields are 70% monocropped and 30% intercropped with cassava, yam, cowpea, and groundnuts. About 80% of farmers are aware of important recommendations on maize production.

In the survey area, and possibly in the whole of the transition zone, more than 60% of the maize is planted with improved seeds, while fertilizer use is just about 40%, depending mostly on availability and farmers' cash resources.

Despite a crisis in spare parts supply, 50% of the land is prepared by tractors. The shifting system seems to be declining and moving to the areas close to the forest where yams and cassava are the most important root crops. A good percentage of farmers (at least 50%) in this area can be regarded as following "improved" practices and are potential users of fertilizers.

In the **forest area**, maize seems to be 25% monocropped and 75% intercropped. According to a survey effected in the Central Region, there are areas where only 4% of maize land is cultivated with fertilizer. These low rates of utilization are explained by the use of the shifting system with long fallow periods, intercropping, and high soil fertility. Maize response to fertilizer application (460 kg/ha) in the forest area is 43% compared with an average of 70% in the whole country. Nevertheless, in some areas where maize is more intensively grown, fertilizer is still required.

In the **northern savannah**, except in the western parts of the northern and upper regions, crop performance is poor because of a long history of field exploitation, drought, and deficiencies of major nutrients (nitrogen) and microelements (zinc). As a matter of fact, drought, wind, deforestation, and continuous monocropping are destroying the agronomic structure of the land, and fertility is declining while topsoil erosion increases.

The cropping system shows both permanent and intensive cultivation where the population density is high and shifting cultivation with long periods of fallow where the density is low. It appears that farmers in this zone are more aware of the benefits of fertilizers and have been using fertilizer for a long time because this input is essential for increased yields, when used in conjunction with other measures that improve soil structure and organic matter, such as reforestation and agroforestry.

Fertilizer is especially needed in those areas (Upper East Region) where population pressure (87 people/km^2) is higher than the national average (50 people/km^2) and land shortage does not allow a shifting system.

Yield Response to Fertilizer Application

Data on yield response to fertilizer application on maize are available from a number of research institutions, including Ghana Grains Development Project (GGDP) which has been conducting research trials all over Ghana for 9 years. Reports indicate that growing maize under appropriate technology and fertilizer use results in yield increases up to 532% compared with traditional technology.

The contributions to grain yields of each recommended component in the different zones are summarized in Table 1. The 1981 trials showed that fertilizer enhanced yields by 54%-64% and thus was by far the most important component in maize production, followed by improved maize variety (22%) and agricultural practices (13%-25%).

Table 1. **Contributions to Grain Yield of Variety, Weeding, Density, and Fertilizer in the Recommended Technology in Forest, Transition, and Guinea Savannah**

	% Contribution	
Component	Guinea Savannah (Minor Season, 1981)	Forest, Transition (Major Season, 1981)
Variety	23	21
Two weedings	3	7
Density	10	18
Fertilizer	64	54

Source: GGDP

The general conclusion from the numerous fertilizer trials in Ghana since 1983 is twofold: first, technical response to fertilizer is higher in cases where good management techniques predominate than in cases where reasonably poor farm management exists, and in fact, good yields are often obtained with row planting, good weeding, and improved seed; second, different zones require different rates of fertilizer depending on the cropping system and soil fertility.

Fertilizer Requirement Rates

In the **forest and transitional** areas, compound 15-15-15 or 20-20-0 should be applied after 2 weeks at a rate of 1 bag/acre (125 kg/ha), and 1 bag/acre (125 kg/ha) of ammonium sulfate should be applied 6 weeks after planting; the quantity of major nutrients is equivalent to 45-19-19 kg/ha of N-P_2O_5-K_2O/ha.

In **savannah and well-cropped sites in transitional zones**, either starter fertilizer (compound) or ammonium sulfate should be applied at a rate of 2 bags/acre or the equivalent of 90-38-38 kg of N-P_2O_5-K_2O/ha. Associated with fertilizer, seed rates of 42,000/ha, row planting, and two weedings are also advised.

Fertilizer Supply Related Problems

Given an adequate and timely supply of essential inputs, adequate guaranteed minimum producer prices, and improved extension services (Lomé III-Rural Sector Program, VORADEP-WB, NORADEP-West Germany, and others), Ghana has the potential for sustainable self-sufficiency in food production, with enough surplus for strategic reserves and some export.

Ghana has a strong comparative advantage in a variety of annual and tree crops. The agronomic potential exists to nearly double yields on most crops. Improved technical packages exist for maize, rice, and a number of other crops. If rainfall is adequate, use of fertilizers on local varieties can lead to a 20%-30% yield increase; if improved (fertilizer responsive) varieties are used, a 100% increase is achievable.

Although average yields of 4.2 tonnes/ha of maize have been obtained from research and field trials, the average national yield in the last decade was only 1 tonne/ha. Yields fell to 0.85 tonnes/ha in 1983 because of widespread drought but increased to 1.18 tonnes/ha in 1984 when rainfall was adequate. About 35% of maize is planted with high-yielding varieties, mainly La Poster and Composite 4.[1] Planting of higher yielding varieties is gradually increasing as more improved seed is being made available by the Ghana Seed Company (GSC).

Input Supply System-The main issues of input supply relate to fertilizer importation and distribution. Because of the scarcity of fertilizers due to foreign exchange shortages and subsidies on the fertilizers, the Ministry of Agriculture (MOA) has been responsible for determining annual requirements (provisioning) and for importing and distributing fertilizers. There is no local production of fertilizers in Ghana.

An increasing share of the import and distribution of inputs other than fertilizer, i.e., agricultural hand tools and agro-chemicals, is being handled by private sector trading houses.

Fertilizer Procurement-The Crop Services Department (CSD) of MOA determines annual fertilizer requirements from consumption estimates submitted by MOA regional offices and the Farmers Services Companies (FASCOMs) operating in the Volta and Upper East and West Regions. The actual quantities of fertilizers to be imported are determined by the foreign exchange allocated for fertilizer imports. Imported fertilizer is allocated to regions according to requirement submittals and considerations of historical use patterns and inventory positions.

The procurement of fertilizer is undertaken by the Crown Agents (CA) acting on behalf of the Bank of

1. Ghana Agricultural Sector Rehabilitation Credit Report-FA (1985).

Ghana (BOG) in respect of the IDA and certain other donor-aided import programs. In other cases, fertilizer is imported by the Ghana National Procurement Agency (GNPA) on behalf of the MOA.

With the establishment of Government-owned FASCOMs, fertilizer distribution has been transferred from the MOA to these companies in the Upper East, Upper West, and Volta Regions. In all the other regions, the MOA continues to be responsible for fertilizer distribution. Delays in importation, transportation, and distribution of fertilizers have been common problems over the past years, involving also the fertilizer for the 1988 crop season.

Fertilizer is imported in bagged form through the Port of Tema. Poor port conditions limit vessel unloading rates. A port improvement program under the "Ports Rehabilitation Project (Tema and Takoradi)" financed by the World Bank, Saudi Fund, and EDF (the latter being involved in Takoradi only) is currently underway.

The CSD contracts an overseas port clearance operation. Fertilizer is discharged from vessels directly onto trucks for haulage to MOA national warehouses at Tema and Swedru and to MOA regional and district depots from which it is trucked to subdistrict sales outlets. The State Transport Corporation (STC) and private truckers are hired to do this trucking. The FASCOMs do most of their own trucking.

Road transport is the predominant mode of moving fertilizer from the port to inland depots. Only limited use has been made of rail transport because few, if any, MOA storage depots are located on rail lines. Inland water transport via Lake Volta and connecting rivers is also limited but holds promise of expansion as new ports are developed and additional barge capacity is added.

With few exceptions, road conditions are poor, particularly in the rural areas, adding to transport time and wear and tear on vehicles. The use of large-capacity trucks is usually restricted to deliveries to regional and district-level depots; smaller trucks are used for deliveries to village-level sales points. Because of the poor state of the roads, private truckers are reluctant (and often refuse) to undertake trucking in the rural areas. This is particularly a problem in the more remote areas because MOA has little transport facility of its own.

Fertilizer Storage Capacity and Warehousing Network–The fertilizer warehousing system consists of a network of national and district depots (Figure 1). Additional storage capacity is available at the subdistrict sales outlets. Overall national storage capacity is estimated at about 114,000 tonnes and is available at national depots (22,500 tonnes), regional and district depots (61,080 tonnes), and retail outlets (30,100 tonnes); thus, existing total storage capacity is about three times that of the 1987 fertilizer import.

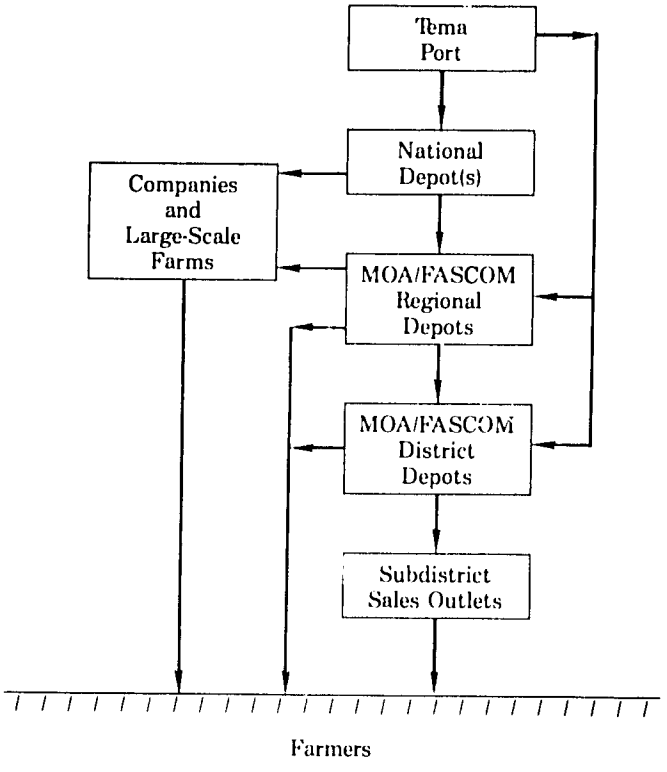


Figure 1. **Fertilizer Distribution System.**

Government-owned national depots at Tema (10,000 tonnes), Swedru (10,000 tonnes), and Kukurantumi (2,500 tonnes) are in excellent to good condition. Regional and district depot capacities are estimated at about 29,150 tonnes and 31,900 tonnes,[2] respectively. Some of these depots are government owned, but many are rented or borrowed (rent-free) from various government and other organizations. Most depots are in acceptable condition for fertilizer storage, but some are in need of extensive repair.

Fertilizers are sold to farmers mainly at MOA/FASCOM village-level sales outlets. In the Greater Accra Region, they are also sold through 26 farmer-operated sales centers. Sales to parastatals, private organizations, and large farmers are generally made at national and regional depots. There are an estimated 400 locations at which farmers may purchase fertilizer. With the exception of the specially designed FASCOM farmer service centers and the sales outlets built by the Ghanaian-German Agricultural Development Project (G-GADP) in the Northern Region, most sales outlets are makeshift facilities. These include rooms in MOA office

2. Ghana Fertilizer Privatization Study–IFDC (1986).

complexes and other government buildings, private dwellings, stalls, and huts.

The general flow of fertilizer from the port to the depots and sales outlets is depicted by the diagram in Figure 2, and the Ghana transport system is shown in Figure 3.

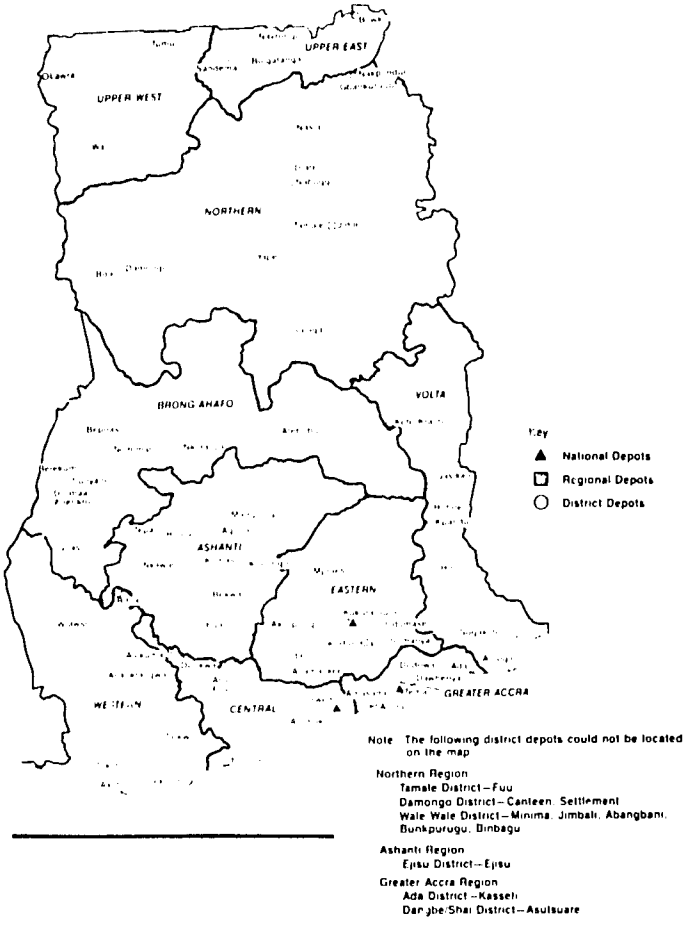


Figure 2. **Ghana Fertilizer Warehousing Network.**

The overall import availability of fertilizer is in the order of 198,000 tonnes (Table 2) for the 3-year period 1988-90, of which 55,000 tonnes will be financed by EDF, 95,000 tonnes by AFDB as part of the World-Bank–Agricultural Services Rehabilitation Project, and 38,000 tonnes by the Dutch and Japanese Governments; the remaining 10,000 tonnes will be met from anticipated MOA stocks carried over from 1987. This would allow fertilization of about 500,000 ha of land under important crops, representing approximately 15.0% of total area planted with important crops.

Fertilizer Demand Related Problems

At the farm level, the importance of fertilizer is not related to yield increase alone; rather, all the farmer's strategies are fully involved. As a matter of fact, the availability of fertilizer allows a permanent farming system. It is hardly possible to grow two or more successful crops without it; thus, farmers are forced to shift. The permanent system brings many advantages in farming and social relations. Land preparation is lighter and easier to mechanize, agronomic and ecological conditions are already known, and land improvements are easier to make.

Other social impacts connected with a permanent farming system include the development of infrastructure facilities such as extension services, markets, shops, banks, etc., which help strengthen social relations and mutual cooperation among farmers.

Farm size (all treated area) and improved techniques are strictly determined by fertilizer. Land and labor are quite easily available and do not seem to be major production-limiting factors, whereas capital is, overall, hardly ever abundant among medium- and smallholders. This is why, when input and machinery use decrease because of cash shortages, labor and land productivity fall and the farm size is reduced.

Credit facilities are difficult to manage when smallholders cannot provide the necessary guarantees required by the banks and when fertilizer availability is limited because of a national shortage of foreign exchange, lack of transport, bad road conditions, and bureaucratic procedures.

Demand of Fertilizer–Fertilizers have been used in Ghana in increasing quantities since 1963, when the FAO–FFHC Fertilizer Program was started on a pilot basis in the Eastern and Central regions. Imports jumped from 1,314 tonnes in 1960 to nearly 8,000 in 1965, due mainly to involvement in large-scale farming and mechanization by the State Farms Corporation, UGFCC, and the Workers Brigade. However, owing to a number of problems, including lack of adequate facilities for fertilizer distribution and marketing, quantities used by small-scale farmers have been very small, ranging from 10% to 15% of the potential use.

Table 3 shows fertilizer imports during 1954-87. Because annual imports have always been limited by funds available from the Government budget for the importation of fertilizers, they usually do not reflect farmer demand for fertilizers. Imports are of two main types: (1) compound granulated fertilizers and (2) straight fertilizers, chiefly ammonium sulfate, single and triple superphosphate, and muriate of potash. These fertilizers are used for direct application to the soil without further mixing.

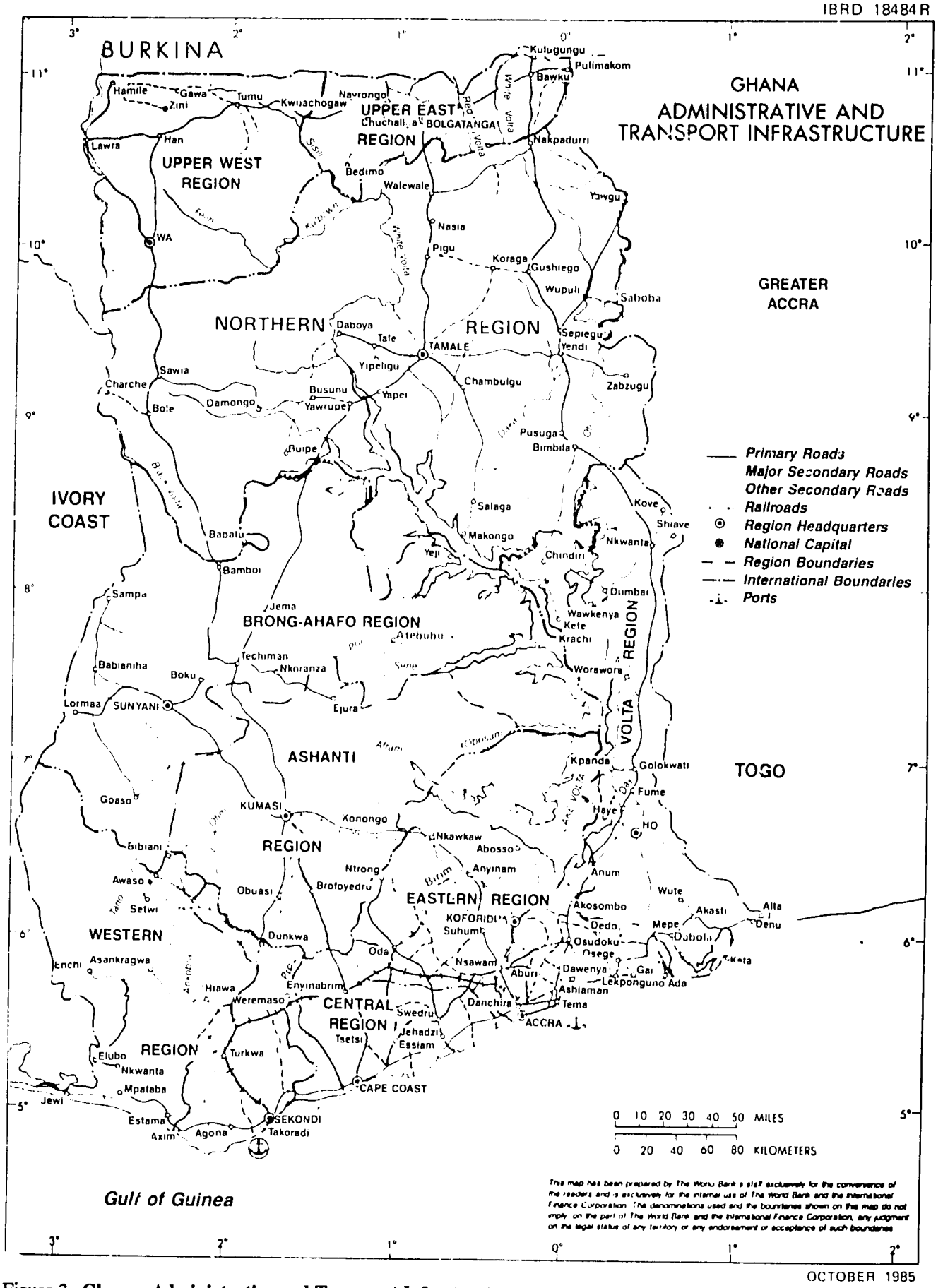


Figure 3. Ghana – Administrative and Transport Infrastructure.

Table 2. **Projected Imports of Fertilizer (1988-90)**

Financing Sources	Year	Fertilizer Type							Total
		20-20-0	15-15-15	A/S (21% N)	SS	10-20-15	M/P	Urea	All Types
		(tonnes)							
Estimated carryover	1988	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10,000
(MOA 1987 stocks)	1989	-	-	-	-	-	-	-	-
	1990	-	-	-	-	-	-	-	-
Subtotal									10,000
SIP (EDF)	1988	-	-	-	-	-	-	-	-
	1989	8,500	8,000	8,500	-	-	-	-	25,000
	1990	10,000	10,000	10,000	-	-	-	-	30,000
Subtotal		18,500	18,000	18,500	-	-	-	-	55,000
AFDB (ADF)	1988	-	-	-	-	-	-	-	-
	1989	12,500	12,500	12,500	5,000	1,000	5,000	-	48,500
	1990	13,000	13,000	13,000	3,000	500	4,000	-	46,500
Subtotal		25,500	25,500	25,500	8,000	1,500	9,000	-	95,000
Netherlands,	1988	1,700	13,509	20,550	-	600	1,050	-	37,409
Japan, and	1989	-	-	-	-	-	-	-	-
Others	1990	-	-	-	-	-	-	-	-
Subtotal		1,700	13,509	20,550	-	600	1,050	-	37,409
All sources	1988	1,700	13,509	20,550	-	600	1,050	-	47,409[a]
	1989	21,000	21,000	21,000	5,000	1,000	5,000	-	73,500
	1990	23,000	23,000	23,000	3,000	500	4,000	-	76,500
Grand Total	(3 year)	45,700	57,009	64,550	8,000	2,100	10,050	-	197,409

a. Includes 10,000 tonnes of fertilizer of all types left over from 1987.

Source: MOA (PPME).

Fertilizer Demand Projections 1988-1990–Accurate projections of future demand for fertilizers in Ghana are difficult to make because of the following considerations:

1. For a variety of reasons, imported fertilizers usually arrive late for use by farmers.

2. Volume imported is usually limited by funds available, and the fertilizer market is never saturated; thus, there is no way of assessing potential demand for fertilizers.

3. Inefficient marketing and distribution of fertilizer result in significant losses.

4. Inadequate crop marketing systems, especially for increase in food crops obtained through the use of fertilizer application, result in decreased effective demand at the farm gate and thus depress the demand for fertilizer.

5. Inadequate extension services staff and facilities fail to provide information to farmers on improved techniques; also agricultural research has not been able to provide many of the answers to problems such as use of suitable seed varieties, diseases, weed and insect-control measures, and other cultural practices that promote increased fertilizer use.

Experience has shown that fertilizer use projections have to be based on realistic assumptions and that the existing conditions in the country must be taken into consideration. The demand projections in this paper are therefore "induced demand" projections and postulate active government intervention to stimulate and influence

Table 3. **Fertilizer Imports During 1954-87**

Year	SA	SS	TSP	MP	SP	MS	Urea	15-15-15	20-20-0	5-20-15 10-20-15	DAP/CAN	3-25-18 2-24-11	Other Mixtures	Total
	(tonnes)													
1954	452	20	29	65	66								42	674
1955	578	89	139	8	41								48	903
1956	1,560	25	56	111	196								95	2,043
1957	208	9	376	4	116								162	875
1958	620	87	66	5	80								115	973
1959	596	124	31	2	247								29	1,029
1960	290	45	210	107	405								257	1,314
1961	633	66	459	275	400								94	1,927
1962	513	47	1,595	25	-		94	165					455	2,894
1963	3,000	2,500	1,060	600	700		-	-					430	8,295
1964	1,000	1,100	192	1,200	300		1,540	1,540					250	7,122
1965	1,300	950	2,477	800	-		550	950					170	7,697
1966	5,018	275	-	-	-			123					13	5,429
1967	182	-	6	287	-			161	13					649
1968	150	150	-	-	-			2,000	900					3,200
1969	1,210	2,300	510	225	-			500	510					5,255
1970	3,140	97	72	38	11	7	3	3,671	1,087	124				8,250
1971	1,943	460	21	179	92	302	3	4,923	544	159				8,626
1972	3,352	287	88	33	137	5	33	5,787	2,085					12,307
1973	8,100	1,500	300	100	48		8	14,278	3,418	930		1,000		16,931
1974	4,150	800	200	10	-		10	6,000	1,000			300		12,470
1975	2,258	1,025	900	5	-		3	16,075	1,475	500				22,241
1976	2,557	582	-	-	-			36,626	4,218					43,983
1977	2,900	6,700	780	70	10	350		4,200	4,000	3,000	4,300	240		26,550
1978	13,739	-	-	-	-			15,896	6,180		1,545		2,000	39,360
1979	19,000	-	-	-	-			39,650						58,650
1980	17,980	-	400	500	-			39,600		500	1,480			60,460
1981	-	-	-	-	-			-						-
1982	14,000	-	-	-	-			20,000	8,000	500	4,000			46,500
1983	-	-	-	-	-			-						-
1984	13,600	-	-	-	-		200	24,550						38,350
1985	5,437	-	-	-	-			21,362	3,200					29,999
1986	8,500	400	-	1,000	-				9,600	600				20,100
1987	10,750			600				3,300	12,750	400				32,200[a]

a. Breakdown of types of fertilizer available only for 27,000 of the 32,000 tonnes.

Source: Ghana Fertilizer Privatization Study - IFDC (1986) and MOA (data for 1987).

farmers (by means of more intensive marketing of fertilizers) and supplement their purchasing power through credit facilities.

Annual requirements are compiled by the fertilizer provisioning officer of Accra-based Crop Service Department of MOA, by MOA regional offices or, in the case of the Volta and Upper Regions, by FASCOMs who act in place of MOA in these regions. According to an IFDC study, (fertilizer privatization study–July 1986) the fertilizer information system needs to be improved as evidenced by the lack of organization, incomplete records, and difficulties in locating information on fertilizer requirements, imports, regional allocations, and inventories.

Usually regional MOA requirements are compiled on the basis of the district extension officer's requests, which are based on their personal "feeling" rather than on a consideration of the real agricultural system, farmers' situation, and the requirements and fertilizer response in different crops.

The Ministry of Agriculture estimates that by 1990 the demand for cereals in Ghana will reach 1.3 million tonnes; 634,000 tonnes of maize, 125,000 tonnes of rice, 272,000 tonnes of millet and sorghum, and the remaining 193,000 tonnes made up of wheat and barley which are imported.

These demand estimates represent 31% increase over the 1988 projected maize production of 484,000 tonnes, 73% increase over the 1988 production estimate of 72,400 tonnes, and 23% increase over the 1988 production estimate of 222,000 tonnes of sorghum and millet. Similar increases in roots and tubers, pulses, nuts, vegetables, and fruits are expected by 1990.

It is the policy of the Government to meet these demand increases over the next 2-3 years through increased productivity on existing lands under cultivation rather than through acreage expansion. The available evidence indicates that fertilizer accounts for between 54% and 64% of the total gain in grain yields in Ghana. Over the 1988-90 period, therefore, only moderate increases in acreage under cultivation are anticipated for the various crops.

Increases in production are expected mainly from increased fertilizer use, the use of improved varieties, proper agronomic and farm management practices, and vastly improved extension services.

On the basis of these expectations, the demand for fertilizer in Ghana is expected to increase from about 78,000 tonnes in 1988 to 100,000 tonnes in 1989 and 107,000 tonnes in 1990 (see Table 4).

Table 4. **Projected Demand for Fertilizer in Ghana, 1988-90**

	1988					1989					1990				
	Projected	Area to be Fertilized		Fertilizer Requirement		Projected	Area to be Fertilized		Fertilizer Requirement		Projected	Area to be Fertilized		Fertilizer Requirement	
Crops	'000 ha	%	'000 ha	Type	Tonnes	'000 ha	%	'000 ha	Type	Tonnes	'000 ha	%	'000 ha	Type	Tonnes
Maize	600.00	20	120	20-20-0/ 15-15-15	30,000	630.0	25	158	20-20-0/ 15-15-15	39,5[illegible]	650.0	25	163	20-20-0/	40,750
				A/S	15,000				A/S	19,750				A/S	20,375
Rice	100.00	20	20	20-20-0/ 15/15/15	5,000	105.0	25	26	20-20-0/ 15-15-15	6,500	110.0	25	28	20-20-0/ 15-15-15	7,000
				A/S	2,500				A/S	3,250				A/S	3,500
Sorghum/ millet	500.00	5	25	20-20-0	3,125	525.0	75	37	20-20-0	4,625	530.0	75	40	20-20-0	5,000
				A/S	6,250				A/S	9,250				A/S	10,000
Groundnut	170.00	5	8.5	S/S	2,000	178.5	5	9	S/S	2,250	180.0	5.0	9	S/S	2,250
Cotton	11.5	100	11.5	15-15-15	1,438	12.0	100	12	15-15-15	1,500	15.0	100	15	15-15-15	1,875
					1,438				20-20-0					20-20-0	
				A/S					A/S	1,500				A/S	1,875
Tobacco	3.0	100	3.0	10-20-15	375	3.2	100	3.2	10-20-15	400	3.5	100	35	10-20-15	438
Oil palm	30.0	60	18.0	15-15-15	2,250	31.5	65	20	15-15-15	2,500	35	70	25	15-15-15	3,125
				M/P	2,250				M/P	2,500				M/P	3,125
Vegetables	50.0	5	2.5	15-15-15	321	53.0	7.5	4	15-15-15	500	55	7.5	4	15-15-15	600
Cowpeas	32.0	5	1.6	S/S	200	34.0	7.5	2.5	S/S	312	35	7.5	2.6	S/S	325
Other crops					6,000					6,300					6,500
Estimated requirement					78,138					100,637					106,738

Source: PPME, Ministry of Agriculture.

These demand estimates are dependent on adequate quantities of fertilizers available at the farm gate at the right time, availability of adequate levels of credit, proper marketing arrangements, and, above all, availability of other complementary inputs that will allow the farmers to obtain high yields. In the absence of accurate statistical data on these factors, the demand estimates here are only indicative of the general direction of fertilizer demand in Ghana over the next 3 years.

Fertilizer Prices

Prices are determined and put into effect when fertilizer imports arrive at the port and c.i.f. prices are known. Until 1983, prices were determined by MOA. In 1984 prices were set by an Agricultural Commodity Pricing Committee based on price calculations by the Prices and Incomes Board (PIB).

Fertilizers have been subsidized since the mid-1960s. Based on the PIB costing method, the subsidy amounted to about 60% in 1985. This was reduced to about 42% in 1986, which remained operative for 1987. In this respect, a bag (50 kg) of compound fertilizer (15-15-15 and 20-20-0) sold at C1,380 and straight fertilizer (AS) at C820. The calculations of the 1988 prices are shown in Tables 5 through 10. Despite the increase in fertilizer prices in 1987 as compared with 1986, due to devaluation of the cedi, the demand for fertilizer by farmers was reportedly still high. It is the intention of the Government to phase out the subsidy during the next 3 years with complete removal by 1990.

Privatization of Fertilizer Operations in Ghana

The Government of Ghana (GOG) through its Ministry of Agriculture has been virtually the sole importer, distributor, and retailer of fertilizers. There is no local production. The Government intends to privatize the fertilizer delivery system in order to reduce the budgetary burden and improve the efficiency of delivery. A study on fertilizer distribution privatization recently made the following recommendations:

1. That the process of privatization be phased over 4 years.

2. That the price subsidy be eliminated in step with privatization.

Table 5. **1988 Fertilizer Selling Price Determination**

		Cedis/50-kg bag
1.	c.i.f. (10-20-15 @ $290/tonne)	C2,755.00[a]
2.	Duty (30% of c.i.f.)	N/A
3.	Sales Tax (20% of c.i.f.)	N/A
4.	Bank Charges (7%)	192.85
5.	Interest on bank loans (9%)	247.95
6.	Transport and handling charges (8%)	220.40
7.	Administrative and other charges (7%)	192.85
8.	Inland freight, delivery expenses, selling expenses (6%)	165.30
9.	Total local expenses	1,019.35
10.	Total expenses (1+9)	3,774.35
11.	Importers Margin (7.5% on 10)	283.08
12.	Wholesale price (11+10)	4,057.43
13.	Retail margin (12% of 12)	486.89
14.	Retail price without subsidy on local expenses	4,544.32
15.	Retail price with 30% subsidy on local expenses	4,238.52
16.	Retail price with 37% subsidy on local expenses	4,167.16

a. At the exchange rate of C190.00 = US $1.00.

Table 6. **1988 Fertilizer Selling Price Determination**

		Cedis/50-kg bag
1.	c.i.f. (Muriate of Potash @ $162/tonne)	C1,539.00[a]
2.	Duty (30% of c.i.f.)	N/A
3.	Sales tax (20% of c.i.f.)	N/A
4.	Bank charges (7%)	107.73
5.	Interest on bank loans (9%)	138.51
6.	Transport and handling charges (8%)	123.12
7.	Administrative and other charges (7%)	107.73
8.	Inland freight, delivery expenses, selling expenses (6%)	92.34
9.	Total local expenses	569.43
10.	Total expenses (1+9)	2,108.43
11.	Importers margin (7.5% on 10)	158.13
12.	Wholesale price (11+10)	2,266.56
13.	Retail margin (12% of 12)	272.00
14.	Retail price without subsidy on local expenses	2,538.56
15.	Retail price with 30% subsidy on local expenses	2,367.73
16.	Retail price with 37% subsidy on local expenses	2,327.87

a. At the exchange rate of C190.00 = US $1.00.

Table 7. **1988 Fertilizer Selling Price Determination**

		Cedis/50-kg bag
1.	c.i.f. (15-15-15 @ $162/tonne)	C1,539.00[a]
2.	Duty (30% of c.i.f.)	N/A
3.	Sales tax (20% of c.i.f.)	N/A
4.	Bank charges (7%)	109.73
5.	Interest on bank loans (9%)	141.10
6.	Transport and handling charges (8%)	125.40
7.	Administrative and other charges (7%)	109.73
8.	Inland freight, delivery expenses, selling expenses (6%)	94.05
9.	Total local expenses	580.01
10.	Total expenses (1+9)	2,147.51
11.	Importers margin (7.5% on 10)	161.06
12.	Wholesale price (11+10)	2,308.57
13.	Retail margin (12% of 12)	277.03
14.	Retail price without subsidy on local expenses	2,585.60
15.	Retail price with 30% subsidy on local expenses	2,411.60
16.	Retail price with 37% subsidy on local expenses	2,371.00

a. At the exchange rate of C190.00 = US $1.00.

Table 8. **1988 Fertilizer Selling Price Determination**

		Cedis/50-kg bag
1.	c.i.f. (S/S @ $165/tonne)	C1,567.50[a]
2.	Duty (30% of c.i.f.)	N/A
3.	Sales tax (20% of c.i.f.)	N/A
4.	Bank charges (7%)	109.73
5.	Interest on bank loans (9%)	141.10
6.	Transport and handling charges (8%)	125.40
7.	Administrative and other charges (7%)	109.73
8.	Inland freight, delivery expenses, selling expenses (6%)	94.05
9.	Total local expenses	580.01
10.	Total expenses (1+9)	2,147.51
11.	Importers margin (7.5% on 10)	161.06
12.	Wholesale price (11+10)	2,308.57
13.	Retail margin (12% of 12)	277.03
14.	Retail price without subsidy on local expenses	2,585.60
15.	Retail price with 30% subsidy on local expenses	2,411.60
16.	Retail price with 37% subsidy on local expenses	2,371.00

a. At the exchange rate of C190.00 = US$ 1.00.

Table 9. **1988 Fertilizer Selling Price Determination**

		Cedis/50-kg bag
1.	c.i.f. (S/A @ $102/tonne)	C969.00[a]
2.	Duty (30% of c.i.f.)	N/A
3.	Sales tax (20% of c.i.f.)	N/A
4.	Bank charges (7%)	67.83
5.	Interest on bank loans (9%)	87.21
6.	Transport and handling charges (8%)	77.52
7.	Administrative and other charges (7%)	67.83
8.	Inland freight, delivery expenses, selling expenses (6%)	58.14
9.	Total local expenses	358.53
10.	Total expenses (1+9)	1,327.53
11.	Importers margin (7.5% on 10)	99.56
12.	Wholesale price (11+10)	1,427.09
13.	Retail margin (12% of 12)	171.25
14.	Retail price without subsidy on local expenses	1,598.34
15.	Retail price with 30% subsidy on local expenses	1,490.78
16.	Retail price with 37% subsidy on local expenses	1,465.68

a. At the exchange rate of C190.00 = US $1.00.

Table 10. **1988 Fertilizer Selling Price Determination**

		Cedis/50-kg bag
1.	c.i.f. (20-20-0 @ $163/tonne)	C1,548.00[a]
2.	Duty (30% of c.i.f.)	N/A
3.	Sales tax (20% of c.i.f.)	N/A
4.	Bank charges (7%)	108.40
5.	Interest on bank loans (9%)	139.40
6.	Transport and handling charges (8%)	123.90
7.	Administrative and other charges (7%)	108.40
8.	Inland freight, delivery expenses, selling expenses (6%)	94.10
9.	Total local expenses	574.20
10.	Total expenses (1+9)	2,122.70
11.	Importers Margin (7.5% on 10)	159.20
12.	Wholesale price (11+10)	2,281.90
13.	Retail margin (12% of 12)	273.83
14.	Retail price without subsidy on local expenses	2,555.73
15.	Retail price with 30% subsidy on local expenses	2,383.47
16.	Retail price with 37% subsidy on local expenses	2,343.28

a. At the exchange rate of C190.00 = US $1.00.

3. That uniform pricing be replaced by a free market system.

The report also emphasized the need to strengthen MOA's Crop Production Services Department to facilitate privatization and rationalization of fertilizer policy. The GOG accepted these main recommendations and has initiated the process of transferring fertilizer procurement and distribution to the private sector.

A phased process of privatization was chosen to allow the development of a wider retail network, a phased reduction of the subsidy, and a smooth transition to free-market pricing. In essence it means privatizing the retail level first, followed by the wholesale level and finally importation. This means that MOA will continue to be involved in the internal distribution and importation at the first stage. It would be purely an importer during the second stage, and it would give up this role at the third stage.

In the first year (1988), the plan was to introduce private retailing of fertilizers in the Volta and Brong Ahafo Regions. In the Volta Region fertilizers are currently distributed through a FASCOM, which is essentially government-owned and was set up in conjunction with IDA Project Credit No. 1009-GH. Distribution in the Brong Ahafo Region, on the other hand, is through the MOA extension service. FASCOM and MOA would withdraw from retailing and instead sell to private retailers from designated stores. The selling price to these stores would be at a discount from the national uniform retail price to reflect a retailing margin. The retailers would be free to set their own retail price in the two regions. Farmer groups and cooperatives would receive the same terms as private retailers. The experience in developing a private retailing network in the two regions in the first year would be used to develop a national private retail network.

In the second year (1989), private retailing will be extended to all of the 10 administrative regions. There will be a uniform Distribution Point Price which retailers will pay and use as the basis for establishing their own retail prices. In areas where it is not possible for the MOA/FASCOM to withdraw from retail sales, for reasons of lack of retailers, cooperatives, or farmer groups, the retail price will provide for retailer margins based on the experience in Volta and Brong Ahafo Regions.

In the third year (1990), MOA will hand over the internal distribution functions to the private sector by limiting sales to wholesalers/distributors from central warehouses at Tema, Swedru, Kukurantumi, and Tamale. The price at each warehouse will reflect the cost at each location. Wholesalers and distributors will fix their own prices to the retailers who in turn will set their own retail prices. The existing general distribution system for goods continues to function adequately up to the main towns, which are distribution centers, and therefore 1 year should be adequate to install a fertilizer wholesaler network instead of 2 years as indicated in the study.

In the fourth year (1991), MOA will relinquish its importation role. In July 1990 it will make a public announcement that the private sector will be permitted to import fertilizers that appear on an MOA-approved list, which will be published. The announcement will indicate an estimate of existing stocks and anticipated stock as at the end of 1990. With this, the transfer of fertilizer procurement and distribution to the private sector will have been completed.

The price subsidy on the local cost of fertilizer importation will be phased out in 3 years. Estimated at 42% for 1987 on the principle that the c.i.f. cost would be fully recovered, the subsidy will be reduced to 30% in 1988 and to 10% in 1989. In 1990 it will be eliminated altogether. Thus by the time the whole fertilizer delivery system is privatized in 1991, there will be no price subsidy, and a free market system will operate.

To facilitate a smooth transition to full privatization within 4 years, the MOA is seeking the services of a person who has had at least 10 years' experience in the marketing of agricultural inputs in a commercial concern. He or she will head MOA's Crops Inputs Development Unit (CIDU) for a minimum period of 3 years. A senior MOA official with at least 10 years' experience in extension and input distributing will be the counterpart of the internationally recruited head of CIDU. CIDU will also have a sales agronomist, with a minimum of 5 years' experience in selling agricultural inputs in the private sector, to assist in the planning and implementation of the privatization process. CIDU will set up a monitoring system based on monthly reports from extension officers to keep track of retailer development and sales. CIDU will be responsible for estimating demand and arranging for procurement, importation, and internal distribution prior to such activities being privatized. A Fertilizer Extension Advisory Committee will be set up in MOA to assist CIDU in imports. It will help in the development of fertilizer recommendations for various crops and conditions.

In summary, privatization of the fertilizer delivery system in Ghana will be completed over 4 years, including the elimination of price subsidies in 3 years and the installation of a free market pricing system. MOA's CIDU will oversee and promote the process of privatization. The series of actions that will be required to complete the process are indicated in the following schedule.

Schedule of Actions by MOA to Facilitate Privatization of Fertilizer Delivery

	Action	Expected to be Completed by	Comment
1.	Appointment of key personnel to CIDU	June 30, 1987	Yet to report
2.	Begin preparation of implementation plan for private retailing in 1988 in Volta and Brong Ahafo Regions	July 30, 1987	Delayed
3.	Invite bids for 1988 supply	August 31, 1987	Completed
4.	Evaluate bids Award bids	November 30, 1987 December 31, 1987	Completed
5.	Announce 1988 prices with price subsidy not to exceed 30%	January 31, 1988	To be announced by end of April
6.	Launch private retailing program in Volta and Brong Ahafo Regions	January 31, 1988	Delayed
7.	Import and distribute fertilizers	March 31, 1988	Slight delay
8.	Invite bids for 1989 supply	August 31, 1988	On schedule
9.	Analyze performance and problems of private retailing in 2 pilot regions	September 30, 1988	On schedule
10.	Finalize plans for launching private retailing in other regions and make public announcement on privatization program	December 31, 1988	On schedule
11.	Award bids for 1989 supply	December 31, 1988	On schedule
12.	Announce 1989 Distribution Point Price with subsidy not to exceed 15%	January 31, 1989	On schedule

La Politique Des Engrais au Kenya

Peter M. Amukoa

Résumé

L'agriculture reste la principale source de produits alimentaires et de devises pour le Kenya. Les engrais sont un des facteurs déterminants pour l'accroissement de la production agricole. Tous les engrais dont le pays a besoin sont importés; les statistiques récentes montrent qu'environ 260 000 tonnes d'éléments fertilisants divers sont utilisées chaque année.

Il est important de noter que la consommation varie avec la pluviométrie, c'est-à-dire qu'elle diminue pendant les années de sécheresse. La majeure partie des fertilisants est appliquée sur les cultures de rente: café, thé, et canne à sucre.

Afin d'augmenter la consommation d'engrais, le gouvernement kenyan s'attache à:

1. Assurer une meilleure disponibilité des engrais.
2. Assurer des retombées économiques intéressantes pour les paysans qui utilisent les engrais.
3. Assurer des crédits aux agriculteurs pour l'achat d'engrais.

La rareté de devises oblige le gouvernement à contrôler les importations faites par le secteur privé. Des restrictions sont donc en vigueur sur les types et les quantités à importer, et un plafond est fixé pour les prix au détail. La politique gouvernementale favorise le développement d'un secteur des engrais privé et actif. Ainsi, toutes les importations autres que celles qui sont financées par l'aide sont faites par des sociétés privées et des coopératives. Les estimations des besoins nationaux sont basées sur les différentes zones de culture et les doses d'application recommandées. Cette méthode présente certaines insuffisances et des efforts sont engagés en vue d'améliorer la fiabilité de ces estimations.

Des difficultés sont apparues également au niveau de la fourniture des engrais au lieu requis et au moment opportun. Les prix des produits sont quelquefois annoncés après le début de la campagne, ce qui pose de sérieux problèmes aux cultivateurs, puisque ces prix varient d'une saison à l'autre. Des efforts sont entrepris pour lever cette contrainte qui freine l'utilisation des engrais, surtout dans les régions reculées.

Fertilizer Policy in Kenya

Peter M. Amukoa

Kenya's Agricultural Sector

Kenya, a republic on the East Coast of Africa, is bordered by Uganda in the west, Sudan and Ethiopia in the north, Somalia to the northeast, and Tanzania in the south. The equator cuts across Kenya at about midpoint. The total land area is about 446,000 square kilometers, most of which is arid or semiarid. High- to medium-potential land amounts to about 20% and is located mainly in the southwest of the country. The altitude ranges from sea level to above 6,000 meters, which indicates climatic variations that allow for a wide range of agricultural activities.

Kenya's population is around 20 million, and the growth rate is close to 4% per annum. In 1979, when the last population census was taken, an average Kenyan woman had eight children. In the early 1960s, there was about 0.8 ha of high-potential land per person. In the year 2000, there will only be 0.2 ha per person. Agriculture is the backbone of Kenya's economy, contributing 30%-35% to the total gross domestic product and about 70% to national foreign exchange earnings. Over 80% of the population lives in the rural area, and derives its livelihood from agriculture.

Kenya gained nationhood in 1963 and since then has developed the agricultural sector to the extent that the production of the main staple food crop, white maize, has kept pace with the rapid growth of her population, thus allowing for national self-sufficiency in food in years of normal rainfall. Food crops, whose importance cannot be ignored, include pulses, potatoes, cassava, wheat, sorghum, millet, rice, wheat, and oilseeds.

Coffee, the main cash crop, has tripled in production since independence and now is dominated by smallholders who account for over 60% of production. In 1985/86 the total coffee production was 114,000 tonnes – 46,000 tonnes from estate farms, and 68,000 tonnes from smallholders. Tea production has, during the same 25 years, increased sixfold making Kenya the world's third largest tea exporter. In 1985/86 smallholders produced about 97,000 tonnes of tea compared with about 46,500 tonnes from estate farms. Other important cash crops in Kenya include sugarcane, pyrethrum, cotton, a variety of horticultural crops and products, sisal, and cashew nuts. Milk and meat production has also expanded rapidly since independence, and the role of the small farmer has been significant here too.

Table 1 shows the distribution of land to various agricultural activities in 1983/84. Only selected activities are considered.

Table 1. **Estimated Areas for Selected Commodities, 1983/84**

Commodity	'000 ha	Percent Total
Milk (pastures)	2,408	44.6
Maize and beans	1,167	22.6
Other starchy root crops	368	7.1
Sorghum and millet	345	6.7
Coffee	150	2.9
Cotton	112	2.2
Fruits	108	2.1
Sugar	87	1.7
Tea	82	1.6
Potatoes and vegetables	80	1.5
Sisal	56	1.1
Cashew nuts	28	0.5
Ground nuts	19	0.4
Barley	11	0.2
Pyrethrum	10	0.2
Rice	9	0.2
Tobacco	5	0.1
Total	5,171	100.0

In short, Kenya will continue to depend on agriculture for food and for foreign exchange earnings for many years to come. Fertilizer is one of the most important factors in increasing agricultural production. Government policies in agricultural development have therefore given it the necessary emphasis.

Fertilizer Consumption in Kenya

Table 2 gives the consumption of fertilizer in Kenya for the past 7 years, 1980/81-1986/87. All the fertilizer is imported. For the past few years, the estimated consumption is about 200,000 tonnes of assorted types. It is

Table 2. **Fertilizer Consumption in Kenya, 1980/81-1986/87**

Year	Stocks Brought Forward	Plus Imports Available	Total Tonnage Forward	Less Stocks Used	Estimated Tonnage (Decrease)	% Change
	(tonnes)					
1980/81	40,170	129,672	169,842	40,701	129,141	-
1981/82	[illegible],701	206,667	247,368	110,936	136,432	+5.6
1982/83	110,936	129,551	240,493	97,708	142,785	+4.6
1983/84	97,708	120,000	219,708	19,348	198,460	+39
1984/85	19,248	184,374	203,622	28,294	175,328	-11.7
1985/86	28,294	345,141	373,435	101,795	271,640	+55
1986/87	101,795	230,125	331,920	104,793	227,127	-16

interesting to note that the potential requirement is about 600,000 tonnes or threefold the present consumption. There is thus a wide gap between what is consumed and what could be consumed. In 1984/85, for example, the requirement was 650,000 tonnes, whereas actual use was 175,328 tonnes. This potential requirement is calculated by relating the targeted area to be planted for each crop and the recommended rates of fertilizer application per crop.

However, we know that farmers, especially most smallholders, do not apply fertilizers at recommended rates and others do not apply at all for various reasons. In planning for fertilizer importation, we consider this figure together with levels of quantities consumed in the previous period, the weather conditions, and the foreign exchange available, among other factors. It is important to consider weather conditions because, as is noted from Table 2, the low consumption of 175,328 tonnes in 1984/85 was due to a drought period. But in 1985/86, when the weather was good, fertilizer importation was increased and consumption rose to 271,640 tonnes.

Fertilizer Use by Crops, 1985/86

Table 3 shows estimated use of fertilizer by crop and farm type in 1985/86. Major cash crops tend to use the lion's share of fertilizer; coffee, tea, and sugarcane use about 60% of the total. The main food crops, maize and wheat, use about 26% of the total while others use about 14%. Over the past few years about 35% of fertilizer use has been on the estate farms, 20% on large farms, and 45% on smallholdings. Of the smallholder consumption, about 60% is used on coffee, tea, and sugarcane and about 20% on maize.

Table 3. **Estimates of Fertilizer Use by Crops and Farm Size, 1985/86**

Type of Crop	Estates	Large Farms	Smallholders	Total
Coffee	31,950	0	29,100	61,050
Maize	1,500	23,550	21,450	46,500
Tea	26,850	0	15,000	41,850
Sugar	19,050	0	20,700	39,750
Wheat	1,500	16,500	0	18,000
Barley	0	7,050	0	7,050
Other horticultural crops	3,000	0	1,800	4,800
Tobacco	0	0	3,810	3,810
Potatoes	0	0	3,750	3,750
Rice	0	0	3,750	3,750
Sunflower and rape	0	2,685	0	2,685
Pineapples	3,000	0	0	3,000
Irrigated crops	0	0	2,400	2,400
Total	86,850	49,785	101,760	238,995
Percentage	36	21	43	100

Returns to Fertilizer Use

Table 4 indicates average returns to fertilizer use per shilling used for fertilizer application on major crops, 1980/81-1983/84.

Table 4. **Average Returns to Fertilizer Use in Crops, 1980/81-1983/84**

	1980/81	1981/82	1982/83	1983/84
Coffee	7.2	7.0	9.4	-
Tea	7.0	4.9	7.5	13.7
Maize	2.5	3.0	3.6	3.0
Wheat	4.0	3.7	4.5	4.3
Sugarcane	0.8	0.7	0.9	1.2
Sunflower	1.6	1.7	3.4	3.0
Barley	2.8	2.6	2.8	2.6

Returns for coffee and tea are much higher than for food crops such as maize, wheat, and sunflower. Would this explain the higher use of fertilizer in cash crops among smallholders? Maybe or maybe not. One needs to be careful in drawing such a conclusion.

Government Efforts to Encourage Fertilizer Consumption

The major objective is to increase the consumption of fertilizers. This is to be done by the following:

1. Making fertilizers available to the farmers.
2. Ensuring attractive returns to farmers when they increase fertilizer use.
3. Providing fertilizer education to farmers through extension.
4. Providing credit facilities and improvement in crop payment systems to enable farmers to purchase fertilizers.

Fertilizer Marketing and Pricing

Importation

As stated earlier, all fertilizer consumed in Kenya is imported. The quantities imported since 1980/81 are indicated in Table 2.

The imports are made up of fertilizer aid supplied in concessional terms by donors and those imported by commercial firms who get import quota allocations. Table 5 shows the breakdown of aid and commercial fertilizers for 1985/86 and 1986/87.

The Government monitors and controls private importation because foreign exchange to purchase fertilizer is scarce. So limitations are set on types and quantities to be imported by each private firm. Maximum retail selling prices are also set by the Government.

Table 5. **Commercial and Aid Fertilizer Imports, 1985/86 and 1986/87**

	1985/86			1986/87		
Fertilizer Type	AID	Commercial	Total	AID	Commercial	Total
DAP	28,500	39,038	67,538	20,000	145,300	65,300
MAP	5,000	3,500	8,500	-	1,000	1,000
TSP	-	15,900	15,900	-	8,000	8,000
NPK 20:20:0	38,349	7,000	45,349	15,000	3,000	18,000
SSP	-	7,000	7,000	-	4,000	4,000
AS	-	12,794	12,794	-	4,000	4,000
CAN	20,000	20,700	40,700	25,000	23,000	48,000
ASN	-	11,200	11,200	7,000	1,400	8,400
UREA	16,600	22,500	38,500	-	8,750	8,750
NPK 25:5:5 + 5% S	13,000	31,000	44,000	5,000	31,175	36,175
NPK 20:10:10	21,000	19,500	40,500	10,000	14,000	24,000
NPK 17:17:17	3,440	3,000	6,440	-	4,500	4,500
NPK 15:15:15	-	200	200	-	-	-
NPK 15:15:6 + 4	-	-	-	-	1,500	1,500
NPK 6:18:20 + 4	-	2,000	2,000	-	1,000	1,000
SOP	-	2,000	2,000	-	40	40
MOP	-	2,100	2,100	-	1,000	1,000
Others	-	2,420	2,420	-	184	184
Total	145,289	199,852	345,121	82,000	151,849	233,849

Because the Government policy is to encourage the development of an active private sector, all fertilizer importation, other than that with donor aid, is undertaken by private firms and cooperative unions. Also large organized users may be allowed to import. The largest importer and distributor is the Kenya Grain Growers Co-operative Union (KGGCU), which imports fertilizer on a commercial basis and distributes it together with some donor aid fertilizer.

In 1985/86, KGGCU imported 15% of the fertilizer imported and distributed 50,000 tonnes of donor aid fertilizers (14.5%). In 1986/87, the union imported and distributed 32% of total fertilizer imports.

Price Control

Maximum retail prices are set by Government for all fertilizer of a particular type.

Problems in Stepping Up Fertilizer Consumption

The examination of the fertilizer situation in Kenya has, so far, been very general. I would like at this stage to reflect a bit on problems, as I see them, in increasing national fertilizer consumption. Indeed, this is an important point of discussion by this workshop.

Estimation of Fertilizer Requirement

As pointed out earlier, estimation of the national fertilizer requirement is based on the estimated crop area and recommended rates of fertilizer application. This estimate has been unreliable and should not be used as a basis for planning importations and distribution. To make this information more reliable, a major effort is now being made by the Farm Inputs section of the Ministry of Agriculture to survey first, the types and quantities of fertilizers used by farmers and then the quantities of fertilizer imported by all authorized importers.

Timing of Importations

Sometimes fertilizer does not reach farmers when it is needed. Fertilizer importations should be timed according to seasons. For example, fertilizer for the long-rain and short-rain seasons should be made available to farmers at the beginning of each of the seasons.

Seasonal Fertilizer Price Variations

Prices of fertilizer in one season may differ from those in the next season depending on the price situation in the world market. This means that there should be at least two fertilizer price reviews per year. After all, unless there are subsidies, and in Kenya we do not believe in fertilizer subsidies, world fertilizer market prices fluctuate widely within a year, and the tendency not to vary prices throughout a year does not make sense.

Another point that should not be ignored is the timing of the announcement of the price changes to farmers. Whereas it may look obvious that prices should be announced before the seasons begin, such announcements are not always made.

Fertilizer Prices and Pricing

Unless subsidies exist, domestic fertilizer prices tend to be very high reflecting the usually high external market prices. Many farmers therefore lack sufficient funds to purchase enough inputs to meet their requirements. So the existence of a situation of low fertilizer consumption in developing countries and particularly in sub-Saharan Africa can reasonably be explained by the inability of farmers, especially smallholders, to purchase these high-cost fertilizers.

One may then ask, why not subsidies? But where are the funds to do this? You would be shifting them away from other requirements of the poor nations. Even if you did that, how far would you go to achieve some kind of impact? And at what cost?

Mineral fertilizers are expensive, and this is a major reason why most farmers do not use them or use very little. In Kenya, fertilizer prices have been determined taking into consideration transport costs from the main port of entry (Mombassa) to the main district centers based on the railway tariff. However, transportation charges for distribution deep into the rural areas have not been included. Profit margins for retailers in rural market areas are small. This has, therefore, tended to lead to limited retail distribution networks deep into the rural areas. Even attempts that have been made to pack fertilizer into smaller units of 25 kg and 10 kg may have failed to increase consumption for the same reason. However, an attempt is now being made to determine appropriate margins at each point in the marketing chain.

Use of Organic Fertilizers

Today, most recommendations on soil fertilization are based on the use of mineral fertilizers. Agricultural extension staff have for the most part tended to either ignore or give little attention to advising farmers on the preparation and use of organic manure as a means of fertilizing soil. This is a serious mistake. It is a mistake that is also made by those who prepare and finance agricultural projects, especially where smallholders are involved. No project, at least among those I have seen, recommends organic manure or includes it in the package of agricultural production inputs.

In my view, more hope exists for the use of organic manure in the fertilization of smallholder farms than for the use of mineral fertilizers. This is a practical reality.

L'Offre et la Demande d'Engrais au Malawi

J. H. A. Maida et E. S. Malinda

Résumé

Les agriculteurs du Malawi, des petits exploitants aux grands planteurs, sont bien conscients du fait que l'emploi des engrais constitue une composante essentielle de toute stratégie visant à un accroissement soutenu de la production agricole par unité de terrain. Le gouvernement s'est donc résolument engagé à investir dans l'achat de cet intrant, bien que les ressources nationales en devises soient limitées.

Les objectifs de la politique agricole du Malawi sont les suivants:

1. Atteindre et maintenir l'autosuffisance en produits alimentaires de base, particulièrement le mas.
2. Développer les exportations agricoles en vue d'augmenter les recettes en devises.
3. Accroître les revenus des paysans afin d'améliorer la qualité de vie en milieu rural.

Les importations d'engrais ont considérablement augmenté durant la période 1978-1985. Elles restent cependant limitées par le fait que le Malawi est un pays enclavé.

L'utilisation des routes traditionnelles par les ports de Beira et Nacala au Mozambique a diminué à cause de la guerre. Des routes d'emprunt par Durban en Afrique du Sud, Harare au Zimbabwe, et Tete au Mozambique, ont été ouvertes mais elles demeurent encombrées et coteuses.

En 1983, le gouvernement du Malawi en coopération avec ADMARC, la Banque mondiale, et IFAD a créé le Small Holder Fertilizer Revolving Fund (SFRF).

Les engrais achetés par cet organisme sont vendus aux petits agriculteurs par l'intermédiaire de ADMARC dans 1 100 centres de distribution et dans beaucoup de petits magasins saisonniers.

L'Etat subventionne les engrais pour qu'ils soient accessibles aux petits exploitants; cependant, entre dix pour cent et vingt pour cent des produits subventionnés sont détournés au profit des grands planteurs.

En vue d'améliorer l'approvisionnement et l'utilisation des engrais aux environs de 1996, le Malawi se propose de:

1. Mettre en place des services améliorés de vulgarisation et de crédit.
2. Favoriser l'emploi des engrais à haute teneur.
3. Constituer des stocks de réserve afin d'assurer la disponibilité des engrais au moment nécessaire et réduire la subvention.

Le gouvernement envisage également de développer l'utilisation des engrais grce à des mesures incitatives destinées à assurer des débouchés pour les produits agricoles et des rapports cot/prix plus avantageux.

Fertilizer Supply and Demand in Malawi

J.H.A. Maida and E. S. Malinda

Introduction

The world's cultivable land is finite, and yet the world population keeps on expanding with time. To meet the basic needs of the expanding world population, therefore, concerted efforts must be made to increase and sustain the production of food, feed, and fiber per unit area of this finite resource.

The increase in crop production per unit area, however, can be achieved if, *inter alia*, the synergism provided by the interaction between the high-yielding varieties (HYVs) and fertilizers is fully exploited. Dr Norman Borlaug, the world-renowned scientist who was honored with a Nobel Peace Prize in 1970 for his work that led to the development of improved wheat varieties, has observed that "If HYVs are the catalyst, fertilizer is the fuel of the green revolution" (Hignett, 1982).

Farmers in Malawi, be they smallholder or estate farmers, are well aware of the fact that fertilizer is a vital component of strategies for expanding and sustaining crop production per unit area. It is mainly for this reason that Malawi, since attaining her sovereignty, has hitherto remained committed to use her limited foreign exchange resources to purchase fertilizers. Fertilizer demand by farmers in Malawi is, however, influenced by several factors, some of which are indicated in this paper.

Because, generally speaking, the ability and inclination of farmers to adopt a given technology is largely a function of a given country's policies, it is pertinent here to indicate from the outset Malawi's agricultural policy as revealed by Malawi's declared main objectives for a sustained agricultural development.

General Statement of Policies and Strategies

Recognition of the fact that "...The vast majority of Malawi's population depends for its livelihood on peasant agriculture..." and that "...It is in this section that the national development effort is being, and must continue to be, concentrated..." (Developing Malawi, 1971) has led the Malawi Government to declare the following agricultural objectives:

1. Attaining and sustaining food self-sufficiency in staple food crops, particularly maize (*Zea mays*).
2. Expanding agricultural exports to generate increased foreign exchange.
3. Improving rural incomes to increase the quality of life in the rural areas.

The fact that Malawi has been able both to attain food self-sufficiency in maize, which enabled the country to have a reserve that in 1985 exceeded 300,000 tonnes of stored maize, and to increase her agricultural exports from a value of 22 million Malawi Kwacha (MK) in 1964 to 421.9 million MK in 1984 clearly indicates that the strategies adopted by the Malawi Government in order to accomplish objectives (1) and (2) given above have been successful. Regarding agricultural objective (3), those who now visit the rural areas of Malawi after an absence of about 25 years are greatly impressed by the fact that the standard of living of the rural population has changed significantly for the better.

The increased agricultural exports achieved by Malawi since independence can be ascribed to the Malawi Government's policies which have (1) hitherto tended to favor an open economy and to stress efforts on agricultural production for export (Kydd, 1982), (2) until recently been conducive to relatively low inflation rates, and (3) resulted into a realistic valuing of the Malawian currency. Price incentives have also been favorable for such crops as maize and tobacco.

Regarding agricultural production by the smallholder sector, the policy of the Ministry of Agriculture has, since independence, been aimed at supporting a gradual transition from traditional to science-based methods of agricultural production, which entail the application, by the smallholder farmers, of the results of research and development, endogenously generated, and of complementary cultural practices.

Fertilizer Supply

It is evident from Table 1 that imports of fertilizers containing N, P, and K increased significantly during the 1978 to 1985 period (National Statistical Office, 1983).

Table 1. **Imports of NPK Fertilizers**

Fertilizer Type	1978	1980	1982	1983	1984	1985
	(tonnes)					
AN and AS[a]	64,730	35,730	43,167	39,227	22,574	8,835
CAN	7,767	5,426	8,228	38,090	26,152	27,798
Urea	539	10,230	11,229	7,360	15,868	11,420
Phosphates	7,142	14,876	15,192	21,339	7,967	10,973
Potassium	1,550	9,553	7,524	9,694	3,301	8,421
NPK & NP	600	9	22,998	48	22,099	23,509

a. AN = ammonium nitrate and AS = ammonium sulfate.

Summarized in Table 2 are types of fertilizers imported during the period 1978 to 1985. Imports of fertilizers into Malawi have, however, been adversely affected by exogenous factors which can best be understood by reference to the geographical position of Malawi.

Geographical Position and Fertilizer Imports

Malawi, covering an area of 118,428 km^2, is a landlocked country (Figure 1) south of the equator. It is about 900 km long and varies in width from 80 to 160 km. It is bordered to the north and northwest by Tanzania, to the east, south, and southwest by Mozambique, and to the west by Zambia.

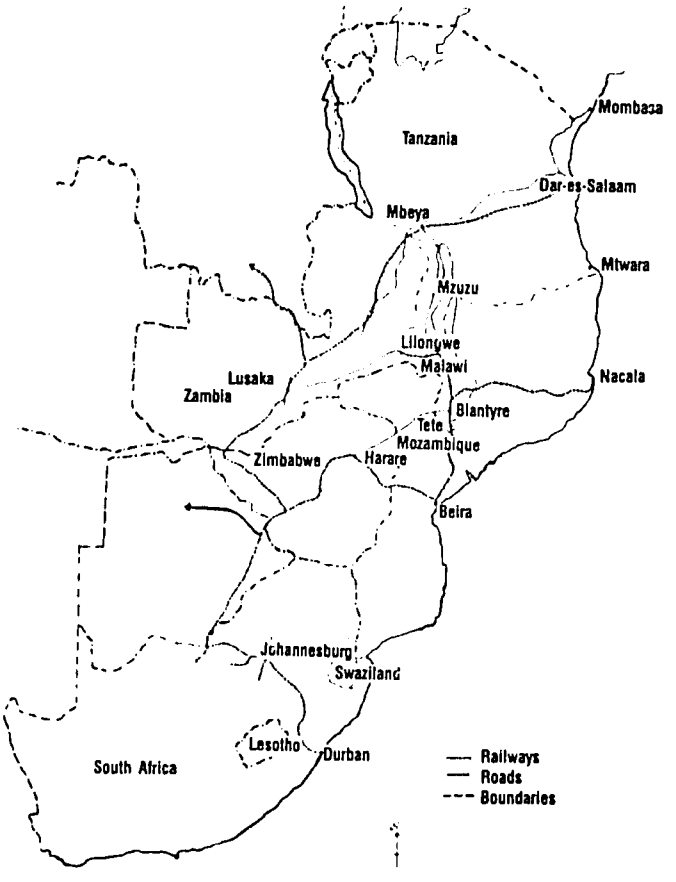


Figure 1. **Malawi's Import Routes.**

Table 2. **Type of Fertilizers Imported**

Types of Fertilizer	1978		1979		1980		1981		1982		1983		1984		1985	
	Tonnes	Value	Tonnes	Value	Tonnes	Value	Tonnes	Value	Tonnes	Value	Tonnes	Value	Tonnes	Value	Tonnes	Value
Sodium nitrate	480	105,947	700	130,227	2,300	460,667	-	-	-	-	556	220,330	-	-	442	240,720
Nitrate	2,846	347,719	11,275	1,510,101	-	79	3,500	813,431	125	23,017	14,318	3,575,290	21	3,486	-	-
Ammonium sulfate	61,884	7,697,724	11,961	1,494,449	35,142	4,648,866	79,285	15,888,144	43,042	7,438,753	24,846	5,548,648	22,553	7,271,722	8,835	2,562,101
CAN	7,767	931,353	14,800	1,608,382	5,426	1,217,488	2,498	636,926	8,228	2,052,728	36,152	8,623,860	38,090	12,644,282	27,798	10,935,058
Urea	839	208,120	3,420	583,115	10,230	2,422,264	7,678	2,326,949	11,229	3,613,479	7,360	2,426,546	15,868	5,416,087	11,420	5,729,403
Nitrogenous fertilizers	20,362	719,369	13,696	2,356,805	3,264	764,403	5,500	1,163,910	2,002	414,740	722	182,089	299	414,655	1,316	995,756
Superphosphate (single)	2,619	202,458	2,201	298,88[illegible]	1,804	287,711	1,499	263,303	1,491	267,634	796	177,235	788	140,387	1,782	413,675
Superphosphate (Double triple)	3,173	440,544	7,809	1,241,669	10,721	2,299,622	9,696	2,322,534	9,424	2,305,636	15,157	5,490,926	6,643	2,121,154	7,196	2,170,600
Phosphate fertilizers	1,350	197,948	1,818	341,206	2,251	633,689	161	50,812	4,277	795,716	5,386	1,832,181	536	148,236	1,995	701,123
Potassium chloride	750	80,351	2,300	266,209	2,553	583,488	2,500	557,631	250	52,326	4,098	1,151,198	1,165	399,448	3,658	1,733,931
	300	44,141	5,368	692,366	3,000	699,211	2,717	799,862	4,524	699,991	3,225	1,233,285	-	-	2,081	1,065,359
Potassic	500	50,422	5,874	1,107,409	4,000	897,402	1,420	434,428	2,750	951,646	2,371	1,055,803	2,136	1,010,688	2,682	1,215,689
Fertilizers (other)	600	179,016	-	-	9	5,188	18	4,205	29,998	8,239,277	48	51,460	22,099	8,504,332	23,502	9,603,008
Total	103,470	14,205,139	81,222	11,650,819	80,000		116,672	25,262,215	117,340	26,854,943	115,098	31,658,901	110,198	37,774,482	92,707	37,366,429
	MK137/tonne		MK143/tonne		MK185/tonne		MK216/tonne		MK228/tonne		MK274/tonne		MK343/tonne		MK403/tonne	

Most of Malawi's traditional import routes have been through Beira and Nacala ports in Mozambique. The war in Mozambique, however, restricted the use of these routes during the past six years, and consequently led to delays in the availability of fertilizer in Malawi. These difficulties left Malawi with no choice but to route most of her imports through Durban (South Africa) and Harare (Zimbabwe), and then via Tete (Mozambique) or Lusaka (Zambia), and occasional imports through Dar-es-Salaam (Tanzania) via what is now known as the Northern Corridor (Figure 1).

The alternative import routes that Malawi is compelled to use are very expensive. Their use, therefore, has been conducive to an increase in prices of fertilizers as is evident from the data summarized in Table 3. In 1983, the Malawi Government in collaboration with the Agricultural Development and Marketing Corporation (ADMARC), the World Bank, and the International Fund for Agricultural Development (IFAD) instituted the Smallholder Fertilizer Revolving Fund (SFRF) which has hitherto been responsible for the procurement of fertilizers for smallholders by means of tenders it seeks worldwide.

Table 3. **Prices of Fertilizers**

Year	20:20:0	AS	CAN	Urea	DAP
	(MK/50-kg bag)				
1972/73	3.45	2.75	3.30	-	-
1973/74	3.45	2.75	3.30	-	-
1974/75	9.00	6.70	8.50	-	-
1975/76	8.50	5.50	7.75	-	-
1976/77	8.50	5.50	7.75	-	-
1977/78	8.50	5.50	7.75	-	-
1978/79	8.50	5.50	7.75	-	-
1979/80	8.50	5.50	7.75	-	-
1980/81	8.50	6.50	10.50	-	-
1981/82	8.50	9.00	10.50	-	-
1982/83	12.60	10.50	13.00	-	-
1983/84	14.50	12.00	14.00	-	-
1984/85	17.50	13.50	15.50	-	-
1985/86	20.50	17.50	19.00	-	-
1986/87	21.00	18.00	19.50	26.00	24.00

Source: Agriculturist's Report No. 1, 1986.

The tenders are required for cost, insurance, and freight (c.i.f.) Dar-es-Salaam and Durban or free on rail (f.o.r.) South Africa. Quotations for overland transport are obtained from about 11 transport brokers/contractors in Malawi, and the cheapest and most reliable are selected. The best combination of supplier's price and overland transport cost receives the award.

Fertilizer procured by SFRF is sold to smallholders through ADMARC. The latter has about 1,100 distribution points (markets), and many smaller seasonal outlets. The price charged is pan-territorial and is subsidized by the Malawi Government. SFRF market prices are generally lower than OPTICHEM (see next paragraph) ex-factory prices and this, *inter alia*, has led to what is known as estate leakage, which is currently estimated to be 10%-20% of SFRF fertilizer. The benefits of subsidy are designed not for estates but for smallholders.

OPTICHEM Malawi Limited procures fertilizers mainly through its parent company FEDMS in South Africa and brings them to its blending/granulation plant in Blantyre where some of it is sold but most of it converted into granular mixtures. All OPTICHEM fertilizers are sold ex-factory at commercial prices. A distribution depot in Lilongwe, about 362 km from Blantyre, sells OPTICHEM fertilizers at prices that reflect ex-factory price plus transport costs from Blantyre to Lilongwe. Relatively small quantities of OPTICHEM fertilizers are sold through Agricultural Trading Company, a distribution company.

The difficulties that attend imports of fertilizer into Malawi have compelled the Malawi Government to explore ways and means of reducing transportation costs of fertilizer and ensuring an uninterrupted fertilizer supply. To a landlocked country such as Malawi, imports of high-analysis fertilizers are much more attractive than those of low-analysis fertilizers because the former allow more essential elements (plant nutrients) per unit weight to be imported, and this results in lower transportation costs.

Fertilizers which, until recently, have been commonly used by smallholders in Malawi are 20:20:0 granular compound, calcium ammonium nitrate (CAN), and ammonium sulfate (AS). Whereas 20:20:0 had been used as basal fertilizers, CAN and AS were used as topdressing. Basal fertilizers are applied to seedbeds before planting and are followed by topdressing of nitrogenous fertilizers.

During the 1985/86 cropping season, however, a decision was made to replace both CAN and AS with urea as a source of N while diammonium phosphate (DAP) was imported instead of 20:20:0 for use by smallholders. It has been cautioned (Maida et al., 1987) that the substitution of S-free high-analysis fertilizers such as urea for S-containing fertilizers such as AS may be conducive to a reduction in crop yields due to S deficiency. Some proposals have, therefore, been made to assay the S status of Malawi soils.

None of the studies hitherto carried out in Malawi with the main objective of producing NH_3, using N_2 from the air and H_2 from the electrolysis of water, have shown results that are economically attractive. The International Fertilizer Development Center (IFDC) was approached recently to carry out a thorough review of the water electrolysis option relative to such other options as coal gasification processes.

While encouraging crop residue management and the use of organic fertilizers, the Research Department of the Ministry of Agriculture in Malawi is conducting investigations aimed at critically evaluating the role biological nitrogen fixation can play in increasing and sustaining crop production in the country. Proposals have recently been submitted (Maida, 1987) to study the agronomic importance of local rock phosphates. It is hoped that the Department of Agricultural Research will collaborate with IFDC and the Department of Geological Surveys in chemical and biological assay of P availability from the Malawi rock phosphates.

The Statement of Development Policies 1987-1996 notes, with reference to fertilizer supply, that strategies for the 1987 to 1996 period should involve, *inter alia*, the following:

1. Increasing "the proportion of smallholders using fertilizer from 23% to 60% by 1996 by means of extension and credit facilities."
2. Encouraging "the use of high analysis fertilizers and a review of current recommendations."
3. Reviewing "existing fertilizer supply arrangements" with a view to establishing "a national stockpile to ensure reliability of supply and reduce recurrent subsidies."

Fertilizer Demand

Access to markets for farm products, remunerative price relationships, and the availability of goods and services that farmers may wish to buy for themselves and their families are some of the incentives that can be instrumental in getting farmers to purchase increasing amounts of inputs such as fertilizer with a view to increasing the production per unit area of a given crop.

To maintain food self-sufficiency, Malawi is now dependent on fertilizer, and it has been observed (Crown Agents, 1987) that without fertilizer the production of maize on all available smallholder land would in 1987 be about 150,000 tonnes short of 1986 consumption. The Crown Agents have also noted that there "... is widespread awareness amongst smallholders of the positive returns to fertilizer use ..." and that "... smallholders will attempt to allocate an increased proportion of income into fertilizer, despite other strong demands on limited earnings...."

Table 4. **Total Uptake of Fertilizer by Smallholders**

Year	20:20:0	AS	CAN	Urea	DAP	Other	Total Material	P_2O_5	N	Total Nutrients
	(tonnes)									
1972/73	2,328	18,752	2,668	84	-	1,353	25,185	466	5,136	5,601
1973/74	4,265	23,017	3,277	873	-	307	31,739	853	6,940	7,793
1974/75	1,636	11,412	666	732	-	401	14,847	327	3,234	3,561
1975/76	2,567	17,456	1,312	210	-	804	22,349	513	4,617	5,130
1976/77	4,148	23,611	1,351	133	-	1,293	30,536	830	6,200	7,030
1977/78	6,374	33,835	3,181	177	-	999	44,566	1,275	9,289	10,563
1978/79	8,971	31,839	3,992	113	-	873	45,788	1,794	9,570	11,364
1979/80	9,170	35,239	4,166	202	-	364	49,141	1,834	10,410	12,244
1980/81	13,469	43,630	4,748	240	-	2,361	64,448	2,694	13,201	15,895
1981/82	10,619	42,508	2,789	673	-	-	56,589	2,124	12,085	14,209
1982/83	22,928	24,845	9,912	74	-	4	57,763	4,586	12,414	17,000
1983/84	21,813	3,232	31,964	-	-	-	57,009	4,363	13,352	17,715
1984/85	26,107	5,444	36,965	37	-	501	69,054	5,221	15,993	21,214
1985/86[a]	25,485	3,585	35,547	-	-	331	64,948	5,097	15,092	20,189
1986/87[a]	21,925	6,699	32,422	5,444	813	-	67,575	4,759	17,521	22,280

a. 1986/87 sales are provisional, and the figure for "Other" in 1985/86 includes some urea. "Total Nutrients" does not include "Other." CAN was 26% until 1985/86 and 28% in 1986/87

It has recently been reported that from 1972 to 1978 consumption of all fertilizers generally increased at an average annual rate of 5.8% on a product basis and 6.8% on a nutrient basis to reach 104,000 tonnes in 1978; this is an equivalent of about 29,714 tonnes NPK or 18,570 tonnes N and 11,144 tonnes P and K. Total fertilizer imports increased during 1978 to 1985 (Table 2); moreover, as Table 4 shows, there was an upward trend in nutrient sales to smallholder farmers during the 1972/73 to 1986/87 cropping period (Nathan, 1987).

The upward trend in plant nutrient sales to smallholders was also observed during the 1987/88 cropping season. By January 29, 1988, the total quantity of fertilizers sold was 71,000 tonnes, while those of N and P_2O_5 were, respectively, 19,984 and 6,383 tonnes. It has been estimated that during the 1987/88 cropping season 74,000 tonnes of fertilizers, including 21,195 tonnes of N and 6,590 tonnes of P_2O_5 will be sold. Table 5 summarizes the estimated total fertilizer demand for the 1987/88 to 1992/93 period.

Policy Statements

Fear of risks from factors that are beyond the farmers' control, factors such as market price fluctuations, is one of the disincentives to farmers in any country to increase amounts of fertilizers purchased with a view to increasing crop production. In Malawi, marketing risks have been reduced by establishing a policy whereby ADMARC sells inputs to smallholders and buys their surplus produce at pan-national prices; the prices are always announced well before each cropping season.

The Statement of Development Policies 1987-1996 notes that the marketing policy to be pursued during the 1987 to 1996 period should entail the following:

1. Encouraging "Malawian traders to be involved in the marketing of smallholder crops other than cotton and tobacco."

2. Delineating clearly "the various roles of the Government, ADMARC, and the private sector with respect to marketing of smallholder crops."

3. Monitoring the "impact of private trader participation in such areas as credit recovery, food security, and the geographical distribution of income from agriculture."

4. Continuing "pre-announced fixed producer prices."

5. Having "the price of maize fixed at a level where marketed production is expected to satisfy domestic demand including the requirements of the strategic grain reserves with other crop prices determined by export or import parties, as appropriate."

6. Investigating "the case for offering specific price incentives for new crops as a means of encouraging diversification."

7. Improving the "maize supply 'early warning' system and participating in a maize supply security system for the SADCC group of countries."

8. Reviewing "the existing and possible alternative arrangements for selling tea and tobacco to assess the opportunity for improving foreign exchange."

9. Developing "marketing strategies in a range of specialist export crops including spices, tree nuts, fresh fruit, cut flowers and vegetables."

Farmers everywhere in the world are responsive to changes in prices offered to them for their farm product. The higher the prices offered, the more prepared they are to use both the increasing amounts of fertilizers and complementary crop production technology in order to increase the production of the crop for which higher prices are offered, especially when crop response to increasing levels of the nutrients added to the soil is known to be economic.

Statements of policy and strategies quoted above clearly indicate that every effort is taken in Malawi to ensure that the relative fertilizer-crop price ratios are favorable for an increased and sustained crop production. The availability of revolving credit funds, which smallholders can use to purchase improved seed and fertilizers, has been instrumental in the increased production per unit area of crops such as maize, groundnuts, cotton, rice, and tobacco.

The credit policy in Malawi is to administer seasonal credit through farmers' clubs. Membership to these clubs is decided by the clubs themselves, and the members to get credit are identified by each club's committee. Most members belonging to these clubs have more than 1 ha of land and are more progressive than the rest of the farming community.

The smallest of the smallholders have not been able to join the clubs and, as a result, have not been able to receive credit. Table 6 indicates the number of farmers who are club members and the total sum of money lent out.

Table 5. **Estimated Fertilizer Demand for 1987/88 - 1992/93 Cropping Period (Crown Agents, 1987)**

	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
Costs:20:20:0/CAN (MK/tonne)	511	503	496	478	477	475
DAP/Urea (MK/tonne)	551	543	536	518	517	515
% 20:20:0/CAN	75	55	40	30	25	30
Average price (MK/tonne)	521	521	520	506	507	507
Existing Users						
Number ('000)	921	949	977	1,006	1,037	1,068
Funds available (MKm)	28.0	29.4	30.9	32.4	34.0	35.7
Fertilizer bought (tonnes)	53,700	56,400	59,400	64,100	67,100	70,500
20:20:0/CAN (tonnes)	40,300	31,000	23,800	19,200	16,800	14,100
DAP/Urea (tonnes)	13,400	25,400	35,600	44,900	50,300	56,400
Very Small Farms (<0.5 ha)						
Number ('000)	272	280	289	297	306	315
Funds available (MKm)	4.0	5.0	6.0	6.6	7.3	8.0
Funds/farm inc. incentive (MK)	25	28	31	32	34	35
Small bags/farms (kg)	45	45	45	60	60	60
Fert (DAP/Urea) bought (tonnes)	6,100	6,300	6,500	8,900	9,200	9,500
Horticulturist						
15.15.15	1,000	2,000	2,500	3,000	3,000	4,000
Smallholder Crop Authorities						
Total nutrient (tonnes)	1,001	1,051	1,104	1,159	1,217	1,278
Total fertilizer (tonnes)	2,700	2,600	2,500	2,600	2,600	2,700
20:20:0/CAN (tonnes)	2,000	1,400	1,000	800	700	500
DAP/Urea (tonnes)	700	1,200	1,500	1,800	1,900	2,200
All Users						
20:20:0/CAN (tonnes)	43,300	32,400	24,800	20,000	17,500	14,600
DAP/Urea (tonnes)	20,200	32,900	43,600	55,600	61,400	68,100
15:15:15 (tonnes)	1,000	2,000	2,500	3,000	3,000	4,000
Total (tonnes)	63,500	67,300	70,900	78,600	81,900	86,700
Northern Region						
20:20:0/CAN	9,060	6,900	5,260	4,240	3,710	3,070
DAP/Urea	4,250	6,940	9,170	11,660	12,850	14,280
Total (inc 15:15:15)	13,310	13,840	14,430	15,900	16,560	17,350
Central Region						
20:20:0/CAN	25,986	19,920	15,256	12,304	10,766	8,992
DAP/Urea	9,268	16,978	23,472	29,628	37,018	
Total (inc 15:15:15)	35,754	37,898	39,978	43,432	45,322	48,010
Southern Region						
20:20:0/CAN	7,254	5,580	4,284	3,456	3,024	2,538
DAP/Urea	6,682	8,982	10,958	14,312	15,494	16,802
Total (inc 15:15:15)	14,436	15,562	16,492	19,268	20,018	21,340
Total	63,500	67,300	70,900	78,600	81,900	86,700

Table 6. **Number of Beneficiaries of Seasonal Credit**

Year	Number of Clubs	Membership	Total Amount of Loan (MK)
1983/84	7,191	180,256	11,583
1984/85	8,148	211,770	15,975
1985/86	8,259	207,996	19,067
1987/87	8,045	206,409	18,289

Source: Field reports and records, Ministry of Agriculture, Lilongwe, Malawi.

Tables 7 and 8 indicate the size distribution of smallholders, fertilizer use, and levels of yield obtained for selected crops.

Table 7. **Size Distribution of Smallholdings**

Hectares	<0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	>3
% of all holdings	23.5	32.3	19.9	10.9	6.3	3.5	4.2

Table 8. **Use of Fertilizer and Yields for Selected Crops by Holding Size**

Holding Size and Crop		% of Area Fertilized	Fertilizer Per Hectare (kg)	Average Yields Fertilized (kg/ha)	Average Yields Nonfertilized (kg/ha)	% of Area Fertilized	Fertilizer Per Hectare (kg)	Average Yields Fertilized (kg/ha)	Average Yields Nonfertilized (kg/ha)
<0.5 ha						**2.0-2.5 ha**			
Maize[a]	L	31.6	20	1,050	680	30.0	102	1,403	963
	M	8.4	252	1,314	635	27.1	114	1,668	694
	C	45.9	472	2,674	1,251	49.6	113	2,669	1,106
	H	61.1	544	3,259	68	84.9	155	3,090	850
Tobacco		16.8	119	0	0	69.3	202	0	0
Other		0.2	331	2,559	280	3.1	116	1,517	475
0.5-1.0 ha						**2.5-3.0 ha**			
Maize	L	11.0	128	1,589	782	25.9	104	1,251	1,097
	M	11.0	152	1,304	695	32.4	107	1,611	979
	C	75.6	199	2,116	890	61.2	165	2,244	750
	H	62.9	266	2,767	1,233	83.8	166	2,864	1,029
Tobacco		52.7	199	0	0	83.7	214	0	0
Other		3.8	198	1,996	380	0.4	192	155	471
1.0-1.5 ha						**>3.0 ha**			
Maize	L	19.3	100	1,305	833	39.7	61	1,518	898
	M	21.0	113	1,462	733	33.2	74	1,317	703
	C	34.4	167	2,265	1,108	57.9	140	1,023	1,248
	H	85.0	221	2,655	742	89.9	115	2,656	966
Tobacco		74.3	207	0	0	88.5	122	50	0
Other		2.4	219	1,521	473	0.8	24	920	405
1.5-2.0 ha						**Total**			
Maize	L	25.9	114	1,358	928	24.2	83	1,390	822
	M	15.8	101	1,450	741	19.0	116	1,436	706
	C	65.5	100	2,048	1,525	52.7	160	2,040	1,146
	H	82.8	218	2,713	1,129	85.2	163	2,785	912
Tobacco		80.5	199	0	0	77.6	180	10	0
Other		0.6	208	883	386	1.1	186	1,744	405

a. L: local, M: mixture, C: composite, H: hybrid.

Crop Response to Rates of Fertilizer Addition

Investigations conducted on farmers' fields in Malawi have demonstrated the mode of crop response to rates of fertilizer additions (Figures 2, 3, 4, and 5). The field yield results have been used to calibrate soil tests, and those farmers who submit their representative soil samples for laboratory analysis are able to obtain fertilizer recommendations based on an economic evaluation of the relation between the soil test and the crop response to rates of fertilizer additions.

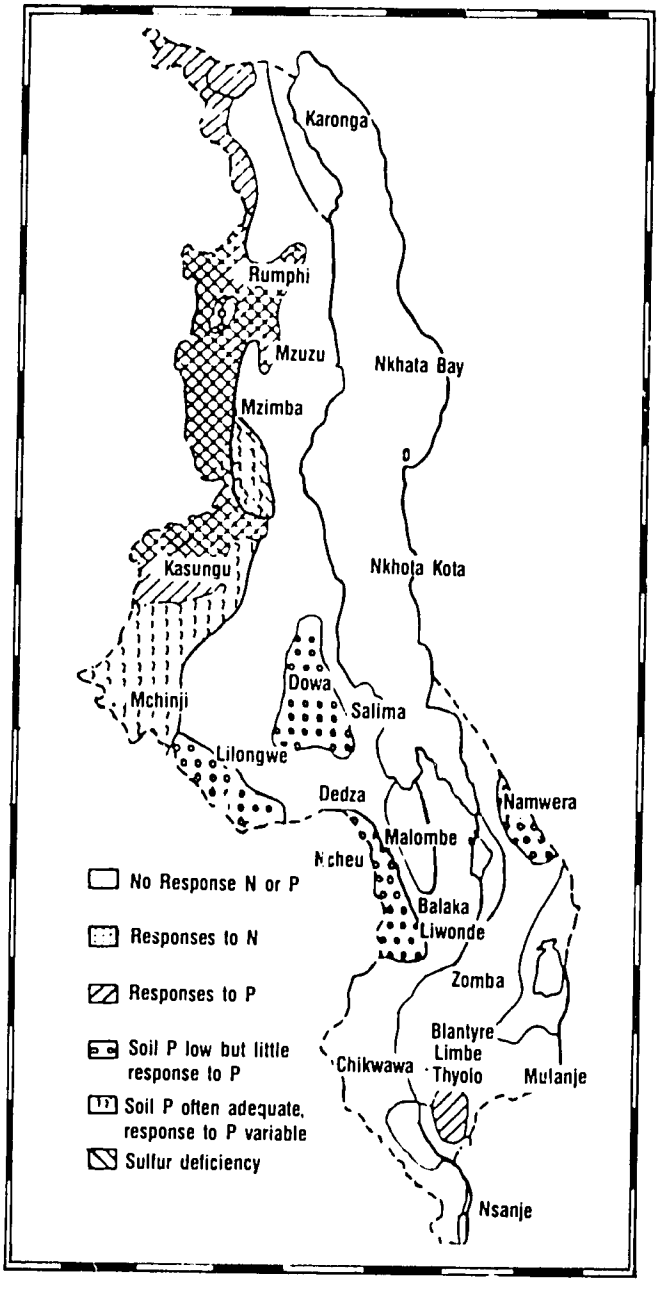


Figure 2. **Provisional Map of Zones of Fertilizer Response (Brown, 1961).**

Transmission of Technology

The technology indigenously developed is transferred to smallholders in Malawi through the Department of Agriculture which is organized into 8 Agricultural Development Divisions (ADDs), 28 Rural Development Divisions (RDPs), 180 Extension Planning Areas (EPAs), and about 1,700 Sections from which field assistants carry out extension work. It is estimated that field assistants spend about 80% of their time on knowledge transfer and about 20% on credit-related activities. A modified Training and Visit (T&V) system of extension is used in Malawi. Field assistants receive a total of about 30 days of training per year.

Credit, crops extension, land husbandry, livestock, and women's programs are all executed through a program of knowledge transfer.

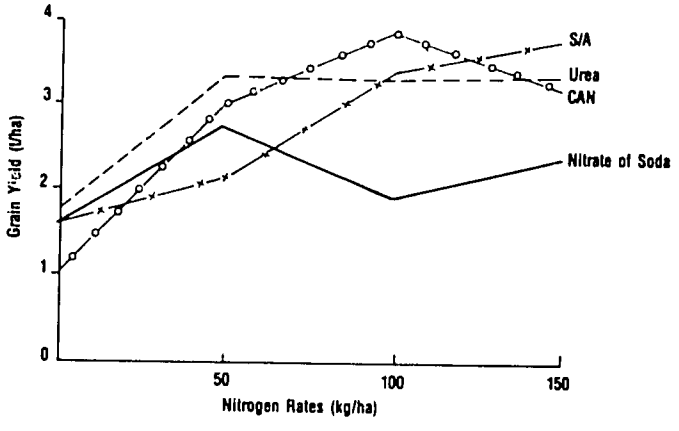


Figure 3. **Effects of Nitrogen Rates and Sources of Nitrogen Fertilizers on Grain Yields of Maize at Bvumbwe Agricultural Research Station.**

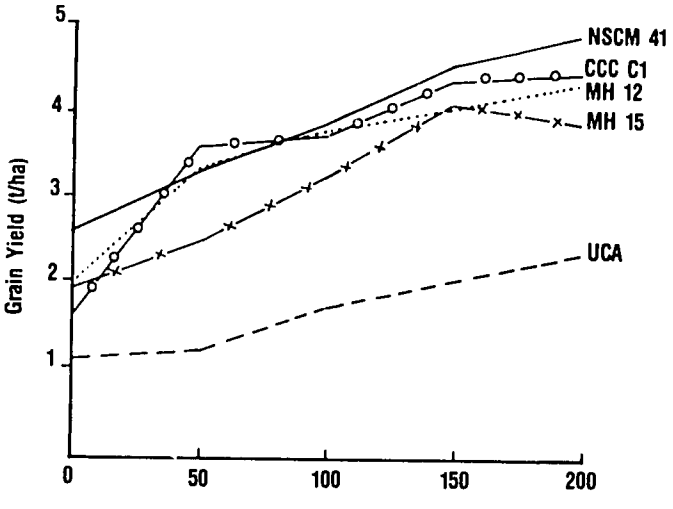
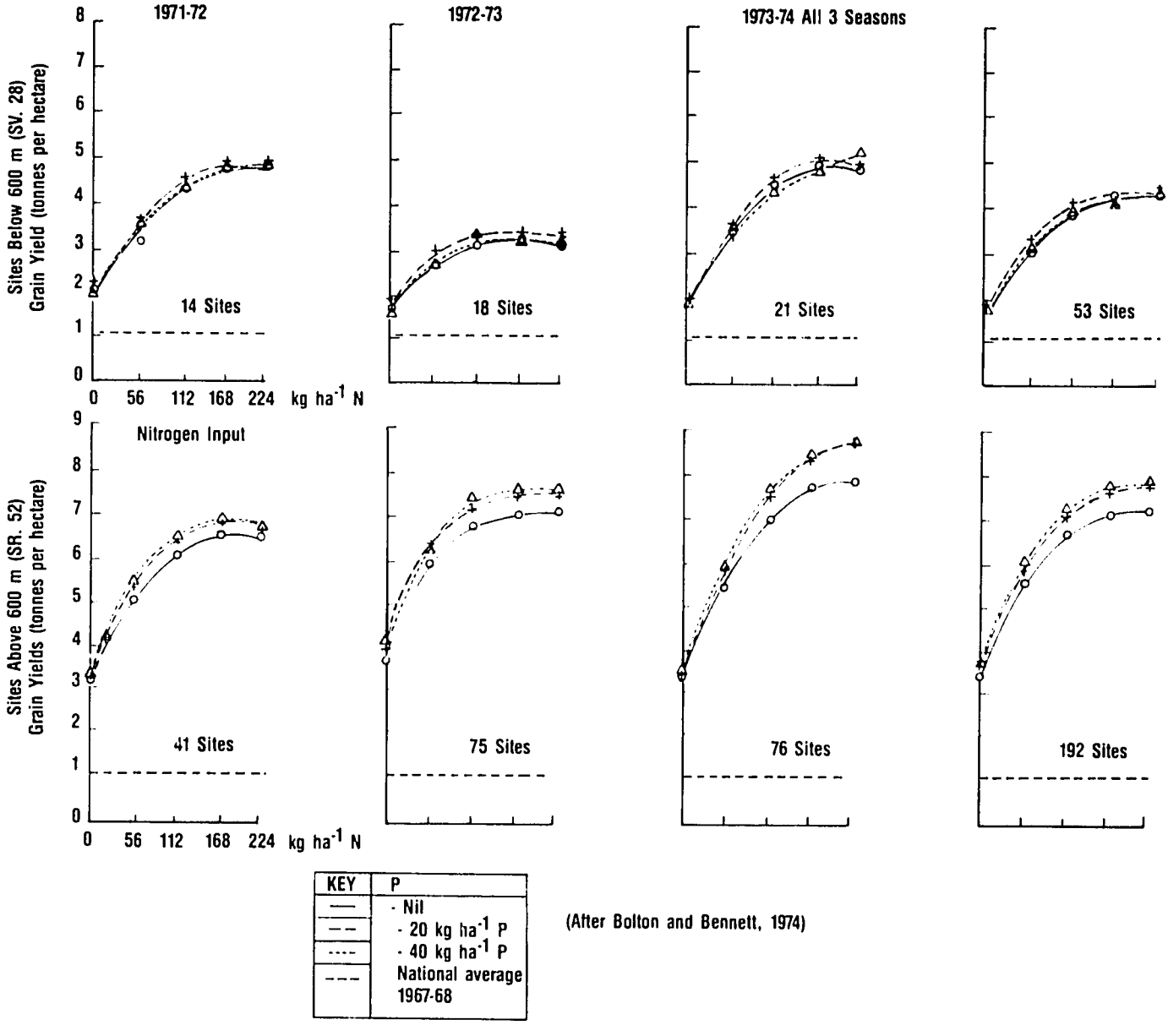


Figure 4. **Effects of Five Nitrogen Levels on the Grain Yield of Five Maize Varieties.**



(After Bolton and Bennett, 1974)

Figure 5. **The Response of Maize to Nitrogen and Phosphate Inputs (All Seasons).**

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Politiques et Programmes Des Engrais: L'Expérience du Nigeria

L. O. Ologide

Résumé

Le gouvernement du Nigeria est conscient du rôle crucial des engrais dans le développement agricole. En effet, avec une population sans cesse croissante, la diminution de l'espace cultivé par habitant, et l'inefficacité de la jachère et de la culture itinérante, les engrais restent le moyen le plus sr de maintenir la fertilité des sols et d'assurer de bons rendements. La politique adoptée par le Nigeria dans ce domaine a pour objectifs de:

1. Développer des systèmes stables et efficaces de production, d'achat, de distribution et de commercialisation.
2. Epargner des devises par la réduction des importations et l'augmentation de la production locale.
3. Assurer des bénéfices raisonnables aux agriculteurs en réduisant les cots et en augmentant l'efficacité des engrais.
4. Favoriser une utilisation rationnelle des éléments nutritifs en fonction des besoins des différentes zones écologiques.

Afin d'augmenter l'offre locale, une usine de superphosphate a été mise en service à Kaduna en 1976 et une usine d'ammoniac-urée à Onne en 1988. Jusqu'en 1976, l'achat des engrais était centralisé. En 1984, cette méthode d'achat a été remplacée par un système d'appel d'offres international conforme aux procédures établies par la Banque mondiale. Les contraintes liées à la commercialisation et à la distribution des engrais sont les suivantes:

1. La difficulté de fournir les engrais à l'endroit requis et au moment nécessaire.
2. Une formation insuffisante des agriculteurs à l'utilisation correcte des engrais.
3. Le manque de crédits.
4. Un rapport défavorable entre le cot des engrais et le prix des produits agricoles.

Le gouvernement fédéral a commencé à subventionner les engrais en 1976 à un taux de 75 pour cent. Entre 1984 et 1986, la subvention a baissé à 28 pour cent, mais après 1986, elle a remonté au niveau de 1976. Les problèmes particuliers au Nigeria dans le domaine de la commercialisation et de la distribution des engrais sont les suivants:

1. Les tarifs élevés du transport routier.
2. Les lenteurs dans le règlement des droits de transport.
3. L'inefficacité du transport routier et ferroviaire.
4. Les pertes dues à la détérioration des produits et à une mauvaise manutention.

Bien que des progrès aient été réalisés dans le secteur des engrais, beaucoup reste à faire pour améliorer les performances agricoles.

Fertilizer Policy and Programs: Nigeria's Experience

L. O. Ologide

Fertilizer consumption in Nigeria dates back to the colonial era. Various tiers of government in Nigeria, through their agencies and at times with the assistance of such international organizations as the World Bank, have made efforts to promote the use of fertilizer to boost agricultural production. Thus, both organic and inorganic fertilizers have been pushed to farmers by an aggressive extension service.

As population increased, resulting in decline of the area under cultivation per capita, bush fallow or shifting cultivation became ineffective to sustain soil fertility and good crop yield. Thus, fertilizers became the only effective tool to restore soil fertility.

Government Policies

The Government has adopted certain policies in order to promote widespread use of fertilizers. These policies could be classified as follows:

1. Supply policy – including procurement and production.
2. Distribution and marketing policy.
3. Pricing and subsidy policy.
4. Research and extension policy.

These fertilizer policies have the following broad objectives:

1. To develop stable and efficient production, procurement, distribution, and marketing systems for fertilizers.

2. To reduce imports and expand domestic supply to conserve scarce foreign exchange.

3. To ensure that reasonable profits are earned by farmers by reducing costs and increasing the agronomic efficiency of fertilizer.

4. To encourage balanced nutrient use consistent with agronomic requirements of crops in different agroecological zones.

Fertilizer Supply Policy

The country depends mostly on imported fertilizers in that local production provides only a small proportion of our national requirement. In order to reverse this trend and to satisfy the ever-growing demand for fertilizer, the Government is taking measures aimed at maximum capacity utilization and expansion of local production of fertilizer. The production policy is therefore to develop domestic production capacity to meet the growing demand for fertilizers.

To achieve this objective, two fertilizer plants have been built. The first is the Federal Superphosphate Fertilizer Company (FSFC) in Kaduna, which was designed to produce 100,000 tonnes of single superphosphate (SSP) annually. Since it was commissioned in 1976, however, the factory has faced logistic and infrastructure problems, leading to frequent shutdowns and, consequently, capacity under-utilization. Previous efforts to improve the plant's production efficiency have not significantly improved capacity utilization, which has remained between 20% and 35%.

The second fertilizer plant is the National Fertilizer Company (NAFCON) in Onne, Rivers State. It is an ammonia-urea complex with an annual capacity of about 700,000 tonnes of products (urea, diammonium phosphate [DAP], and compound fertilizers). It came on stream in 1987 and was commissioned in February 1988. It has produced over 60,000 tonnes of urea and 12,000 tonnes of DAP. The mixed fertilizer complex is yet to come on stream. The Onne factory is expected to make available over 300,000 tonnes of various grades of fertilizers for the domestic market in the 1988 cropping season.

Procurement Approach

Fertilizer procurement was centralized nationally in 1976 with the creation of the Fertilizer Procurement and Distribution Department (FPDD) to collate state fertilizer requests from all agencies and subsequently arrange importation. The main thrust of Government policy on fertilizer procurement is to purchase the best quality fertilizer at the minimum costs either locally or internationally. In 1984 the procurement approach changed to open international competitive bidding using the World Bank guidelines on procurement in order to ensure purchase at fair competitive prices. Although the Government is no longer funding importation with loans from the World Bank, the Federal Government still applies most of the Bank's guidelines on procurement in purchasing its fertilizer from the international market.

Fertilizer Distribution/Marketing Policy

Modern distribution and marketing systems operate to resolve certain constraints that militate against the efficient use of fertilizer. These constraints include the lack of fertilizer at the right time and at the appropriate place, lack of knowledge about correct use of fertilizer by farmers, lack of credit, and unfavorable fertilizer/product price relationships.

In Nigeria, the fertilizer distribution and marketing system is funded, regulated, and supervised by the Government or its related agencies. This is essentially to ensure the timely availability of fertilizer at uniform prices throughout the country and to promote increased consumption through education and promotional activities. Before 1986, FPDD was responsible for delivering both the imported and the locally produced fertilizers to primary distribution points in the states. Currently, FPDD's role ends by making the fertilizer available to state government agencies and cooperative societies at the ports and to fertilizer factories, which eventually take the products to their storage depot and sale points. Cooperative societies and commissioned agents are being actively involved and used by state governments to sell fertilizers to farmers at the grassroots level at uniform prices throughout the country.

To maximize distribution efficiency, reduce costs, and make fertilizers available at the appropriate time and at a good price, the Federal Ministry of Agriculture concluded plans in 1986 to commercialize fertilizer marketing in the country. The move was, however, shelved for the time being because of the effect of the foreign exchange market on fertilizer pricing.

Fertilizer Pricing and Subsidy Policy

The fertilizer pricing and subsidy policy has remained a major instrument of agricultural development in Nigeria. It has not only reduced the cost of fertilizer to the farmer, thereby stimulating large-scale fertilizer use or consumption, but also has encouraged income distribution to the less privileged rural areas. The Federal Government became involved in subsidizing fertilizer in 1976 when the procurement and distribution of fertilizer was centralized. Between 1976 and 1983, the level of total subsidy was 75%. The level of subsidy fell to 28% between 1984 and 1986. However, despite the subsidy, the retail price of fertilizer rose from ₦2.5/50-kg bag to ₦10.00/50-kg bag between 1976 and 1986. Although the Government plans to phase out the fertilizer subsidy by 1990, it has left the retail price of fertilizer at ₦200/tonne since 1986 in order to encourage farmers to use fertilizer, which is now 75% subsidized. Table 1 shows the fertilizer price and subsidy rate from 1984 to 1987.

Table 1. **Fertilizer Price and Subsidy Rate, 1984-87**

	Price		% Subsidy	
Year	Projected	Actual	Projected	Actual
1984	5.82	5.50	50	52.4
1985	8.11	7.50	40	38.9
1986	10.20	10.00	35	28.0
1987	11.94	10.00	30	75-80

Source: Composed from Nigerian Fertilizer Import Loan II, Report 1985.

Fertilizer Research and Extension Policy

Fertilizer and extension programs focus generally on the development of a package of fertilizer recommendations for the different crops in the various agroecological zones. These recommendations are designed to improve agronomic efficiency through the use of better varieties, fertilizer types, and management practices. To this effect, FPDD has initiated a fertilizer demonstration program, which will put in place a structure that allows continuous reevaluation of fertilizer recommendations through research and demonstration. It will also assist in the development of a database that allows agronomists, soil scientists, and economists to study the role of fertilizers in national agricultural developments.

The program has its National Coordination Center at Ibadan and operates through zonal coordinators in the five ecological zones in the country. In Nigeria, three broad ecological zones based on rainfall and vegetation could be easily recognized with respect to fertilizer use.

1. The Rain Forest Zone has rainfall of 1,500-4,000 mm annually. In this zone, tree crops, oil palm cocoa, etc., along with cassava and yams are cultivated in the southern portion; grains such as cowpea and maize are also grown along with cassava and yams. Tree crops require a fertilizer formulation of 1:1:2 (NPK); magnesium (Mg) is required to correct a deficiency. Potassium, also critically deficient, is required in large quantity within this zone; hence, 12-12-17+2MgO is recommended for tree crops. The consumption of these types of fertilizer is prominent in Bendel, Lagos, Rivers, Cross River, Anambar, and Imo States. For yams and cassava, crops which require high levels of K and N, a formulation ratio that is close to 2:1:2 has been found useful.

2. The Middle Belt Zone has annual rainfall of 1,000-1,500 mm. This area is the grain belt and covers the derived and guinea savannah areas. The grain

crops are maize, sorghum, rice, soybean, and cowpea. The States in this zone – Niger, Bauchi, Gongola, Benue, Kaduna, and Kano – consume most of the fertilizers locally produced and imported.

3. The Sahel Zone has annual rainfall of less than 1,000 mm. Most parts of Sokoto, Katsina, Borno, and the northern part of Kano fall within this zone. The major crops grown are sorghum, millet, groundnut, wheat, and cotton.

It is pertinent to point out that over 50% of the fertilizer consumed in Nigeria is used in the Middle Belt and less than 20% in the Rain Forest Zone.

Problems in the Fertilizer Distribution System

Several problems militate against the objectives of making the right type of fertilizers available to the farmers in the right quantity and at the right time. Each operational aspect is affected by certain factors that have an adverse impact on the whole process of delivery of fertilizers to the farmers.

Supply Problems

The late release of Government funds and the inadequacy of such funds when released compound the procurement exercise. In turn there are delays in the establishment of letters of credit, which must be in place before fertilizers are shipped. Even where the local currency is available, the foreign exchange is not adequate to import the fertilizers at the critical period when most needed for application. These delays in turn affect the actual time of arrival of the fertilizers and quantities available for effective use during any particular crop year.

Fertilizer purchases are arranged through one massive tender at the onset of any cropping season. This approach not only exposes the system to unfair pricing by international fertilizer manufacturing cartels and big fertilizer brokers but also prevents the country from entering the international market when the prices of the various grades of fertilizers are most favorable to the country.

The problems of procurement of raw materials, coupled with technological, logistic, and administrative problems, make supply from local plants difficult and hence below expectation. Since its commissioning in 1976, the FSFC Kaduna has achieved a maximum of only 40% capacity utilization. The NAFCON Plant at Onne, Port Harcourt, though recently commissioned, is yet to start producing NPK compound fertilizers, which are the most popular among Nigerian farmers.

Marketing and Distribution Problems

The problems of marketing and distribution could be classified broadly into logistics/distribution planning problems and transportation problems. The logistics problems are usually caused by late arrival of vessels at the ports as a result of late establishment of letters of credit.

1. **High Road Freight Rate** – Road is the major mode of transporting fertilizer to the ultimate user. Over 80% of the fertilizer distributed is by trucks. Since July 1987 the road haulage cost has increased by 85%. This has significantly increased the cost of delivering fertilizers.
2. **Delay in the Settlement of Transport Claims** – As a result of bureaucracy and the unpredictable nature of release of funds to Government agencies, including FPDD, transport bills of appointed fertilizer transport firms are not promptly paid, and this adversely affects the supply of trucks at the ports. This often prompts the transporters to hold fertilizers in their private storage depots in the port cities before they are moved to final destinations in the states.
3. **Poor Performance of Other Modes of Transport** – The rail performance has been very poor because of problems ranging from lack of spare parts to insufficient cargo haulage wagons and high percentage of losses in transit. Waterway transportation is not popular because this mode of transportation is slow and most of the internal waterways are not navigable throughout the year. The losses due to deterioration by poor handling are high.

Table 2 shows the intermodal mix of transportation during the years 1984-86.

Table 2. **Intermodal Mix of Fertilizer Transportation, 1984-86**

	1984	1985	1986	Total
Road	716,000	1,066,144	579,847	2,361,991
Rail	75,564	70,760	7,861	154,185
Water	8,436	2,000	2,000	12,436
Total	800,000	1,138,904	589,708	2,528,612

Source: FPDD, Lagos.

Conclusion

There is no doubt that the various fertilizer policies and programs have made some positive impact on fertilizer consumption. However, fertilizer use in Nigeria has not developed as much as anticipated, and there is much to be done to improve the overall performance of this subsector of Nigeria's agriculture. It is hoped that by sharing the experiences of other countries participating in this workshop, Nigeria shall benefit immensely in the area of fertilizer program implementation.

Fertilizer Use in Senegal and Perspectives

Waly Ndiaye

During the 1960-80 period, the agricultural program (Programme Agricole: PA) that was in place in Senegal stimulated fertilizer use through subsidies, credit, extension, research, and official marketing channels for groundnuts. The repayment of credit by farmers was made during groundnut sales. From 1960 to 1980, fertilizer use doubled on the average during each decade. From 1981, agricultural policy changed and government subsidies for fertilizers were reduced. During 1981-83, fertilizer use declined considerably, particularly on millet/sorghum and groundnut.

In 1984, a new agricultural policy (Nouvelle Politique Agricole: NPA) was instituted in the context of structural adjustment programs to promote the privatization of the fertilizer sector and to gradually eliminate government subsidies. This profound change in fertilizer policy resulted in a sharp decline in fertilizer use during 1986-88. The privatization of the fertilizer sector is seriously hampered by constraints that stem from the nature of the product and its domestic market.

There is still a lot to be learned about how to develop a private domestic fertilizer sector. Research efforts should focus on reducing the cost of fertilizer per unit of output and increasing the use of local raw materials for the production of mineral and organic fertilizers.

L'Engrais Au Sénégal Situation Et Perspectives

Waly Ndiaye

Historique

De 1960, année d'indépendance du Sénégal, à nos jours, l'emploi de l'engrais a connu de nombreuses fluctuations. Considérant les objectifs d'accroissement de la production agricole impliquant l'augmentation de l'utilisation de ce facteur de production, la politique gouvernementale, appliquée dans ce domaine, a toujours oeuvré en faveur de la diffusion de l'engrais selon diverses modalités tenant compte des contraintes sociales et économiques du pays.

Les principales périodes marquant l'évolution de cette politique peuvent être résumées comme suit :

de 1960 à 1980

Afin de pourvoir au développement du secteur agricole, constituant la base de son économie, l'Etat sénégalais a mis en oeuvre un Programme Agricole (P.A.), chargé d'assurer l'approvisionnement du monde rural en facteurs de production (semences, engrais, produits phytosanitaires matériels agricoles, produits vétérinaires, matériels d'élevage,...). Dans ce cadre, l'engrais bénéficiant d'une subvention étatique importante, de même que les autres intrants, a été cédé aux producteurs à des prix extrêmement bas. Par ailleurs, il était distribué à crédit, avant la saison des pluies, et son remboursement s'effectuait sur la récolte arachidière commercialisée.

de 1980 à 1984

En vue de l'allégement du poids de la subvention sur le Trésor Public d'une part, et d'amener progressivement le producteur à prendre en charge le coût réel et non par paiement en différé d'autre part, l'Etat prit les mesures ci-après :

- Instauration d'une retenue obligatoire sur l'arachide commercialisée pour financer le Programme Engrais de la campagne suivante. Cette mesure n'a pas pu être appliquée durant la campagne 1981/82 (2 FCFA/kg d'arachide) ; mais elle l'a été en 1982/83 et en 1983/84 (5 FCFA/kg d'arachide) ;
- Vente de l'engrais au comptant durant les deux dernières campagnes précitées : à 25 FCFA/kg en 1982/83 et à 50 FCFA/kg l'année suivante.

Ces deux périodes, celle du P.A. et celle de l'après P.A. présentent, néanmoins, quatre caractéristiques communes :

- La garantie d'approvisionnement des cultures de rente (arachide, coton), alors que la fourniture d'engrais aux céréales et autres cultures vivrières n'était pas assurée de manière systématique ;
- la subvention et le crédit constituaient les deux fondements de la politique en matière d'engrais ;
- la distribution et la commercialisation étaient sous le monopole étatique et para-étatique ;
- la vente au producteur de l'engrais à un prix unique, malgré la différence de coûts résultant de la composition en éléments *IL11*nutritifs et du conditionnement des engrais ;

de 1984 à nos jours

En 1984, le Gouvernement du Sénégal a adopté la Nouvelle Politique agricole (N.P.A.) afin de relancer l'agriculture sur des bases garantissant un développement socio-économique réel et durable. Concernant la distribution et l'approvisionnement en engrais, la Nouvelle Politique Agricole caractérise la volonté du Gouvernement à se dégager de tout rôle, pouvant être repris par le secteur privé (producteurs ou autres opérateurs économiques). La suppression graduelle de la subvention des intrants, dès 1986, n'est plus supportée par le Trésor Public. Des organismes donateurs peuvent, toutefois, dans le cadre de programmes ponctuels, apporter leur contribution à la subvention de l'engrais. C'est ainsi, en 1984/85, que l'U.S.A.I.D. a mis gratuitement à la disposition du Sénégal 12 000 T d'engrais et finance depuis 1986 un programme de subventions dégressives pour l'engrais portant sur trois ans : 1986/87-24 000 FCFA/Tonne, 1987/88-16 000 FCFA/Tonne, 1988/89-8 000 FCFA/Tonne.

Depuis, les opérateurs économiques privés et les producteurs privés (individuels ou regroupés par catégorie socio-professionnelle) peuvent bénéficier de cette subvention ; les S.R.D.R. (Sociétés Régionales de Développement Rural) étant exclues de ces avantages.

Par ailleurs, durant ces premières années de mise en application de la Nouvelle Politique Agricole, le Gouvernement, soucieux de permettre aux producteurs de disposer des engrais à des prix économiquement acceptables, a pris d'autres mesures parmi lesquelles figurent notamment :

- la loi 85.05 exonérant les engrais de toutes taxes,
- la libéralisation progressive des importations d'engrais.

De cette rétrospective historique, caractérisant l'évolution de la politique du Sénégal en matière d'engrais, et après une phase assez longue de vulgarisation de cet intrant, phase importante qui a permis au monde rural de découvrir l'intérêt de l'engrais, il se dégage que le Gouvernement s'est orienté, de manière progressive et déterminée, vers l'application d'une nouvelle politique des prix aux producteurs vers une prise en charge des circuits de distribution et de commercialisation par les opérateurs économiques privés.

Les mesures contraignantes, prises à cet effet, n'ont pas été

sans incidences sensibles, notamment au niveau de la consommation de cet intrant. Les difficultés d'application de ces mesures ont été accentuées par les aléas climatiques et économiques, intervenus à la fin du Programme Agricole.

Face à de telles contraintes, les autorités sénégalaises ne cessent de rechercher les voies et les moyens afin d'apporter les solutions les mieux adaptées à la problématique de l'approvisionnement, de la demande du secteur des intrants agricoles en général, et de l'engrais plus spécifiquement.

La Problématique De L'Approvisionnement En Engrais

Production

Le Sénégal est un important producteur d'engrais au sein de la CEAO (Communauté Economique de l'Afrique de l'Ouest). Cette production d'engrais s'étale sur deux périodes :

- **La fabrication d'engrais avant 1984 :** Dans le but inciter d'impulser le développement du secteur agricole, grâce à l'utilisation de l'engrais produit localement à partir de phosphates, les autorités sénégalaises ont créé deux sociétés, au cours des premiers Plans de Développement Economique et Social (PDES) : la SIES (1962) pour la production d'engrais complexes, en vue d'alimenter le marché sénégalais ; la SSEPC (1968) dont l'activité portait sur l'importation de l'urée et sur la production d'engrais présentant des caractéristiques différentes (engrais utilisés pour les produits maraîchers) de celles de la SIES. Il faudrait souligner que face à un marché intérieur dépressif et aux exportations stationnaires, la SIES s'est retrouvée en situation de sous-activité de production, conduisant à une détérioration de sa situation financière.

Quant à la SSEPC, face à la fusion de la SIES et des ICS en 1984, ses activités ont été interrompues et la commercialisation des produits finis, a été attribuée à la SENCHIM.

- **La fabrication des engrais au Sénégal depuis 1984 : les ICS** Créées en 1976, les ICS ont pour mission d'implanter, au Sénégal, un ensemble industriel basé sur la transformation et la valorisation des phosphates.

Différents types d'engrais, contenant comme composants principaux l'azote (N), le phosphore (P), la potasse (K) et le souffre (S), sont fabriqués principalement par voie chimique. Des oligo-éléments, tels que le bore (B), sont incorporés sur demande.

Les engrais produits par les ICS résultent de trois formules :

- les engrais simples : Le super phosphate simple (SSP),
  le super phosphate triple (T.S.P.) ;
- les engrais binaires :les engrais NP (sans potasse),
  le phosphate mono-ammonique (MAP),
  le phosphate diammonique (DAP),
  les engrais PK (sans apport d'azote) ;
- les engrais ternaires :les engrais N.P.K.

La fabrication des engrais destinés au Sénégal présente des problèmes pour les ICS en particulier, car les prix sont fixés tardivement en saison et les quantités par formule ne sont pas connues comme tel est le cas pendant la période du Programme Agricole.

En 1985, la production totale d'engrais des ICS a été de 87.000 tonnes, réparties ainsi :

- DAP : 45.000 T
- SSP : 7.000 T
- TSP : 6.000 T
- NPK + PK (O-15-20) : 29.000 T

Au Sénégal, on utilise, en général, les six formules d'engrais suivantes :

- 6-20-10 pour l'arachide et le niébé
- 14-7-7 pour le mil
- 10-10-20 pour les produits maraîchers
- 8-18-27 pour le maïs
- 6-14-37 pour le coton
- 18-46-0 (DAP) pour le riz.

En dehors du DAP, qui est exporté, les autres formules sont spécifiques au Sénégal et représentent des quantités très faibles par rapport à la capacité de production, surtout en ce qui concerne l'engrais pour les produits maraîchers, qui, de plus, doit être produit en contre-saison.

Importations

Malgré la création d'unités de production, le Sénégal reste un pays importateur d'engrais.

Les importations sénégalaises d'engrais ont connu une situation évoluant en "dents de scie" avec une forte baisse entre 1968 et 1971 et une nette remontée jusqu'en 1976 avant d'accuser une nouvelle phase descendante (Cf. tableau n/e1).

Tableau 1. **Evolution Des Importations D'Engrais Au Sénégal**

Import. années	Volume (tonnes)	Valeur (en millions de FCFA)	Prix moyen (en FCFA/kg)
1965	21.767	356	16,4
1966	30.188	488	16,2
1967	46.888	669	14,3
1968	31.293	385	12,3
1969	4.059	34	8,4
1970	9.659	106	11,0
1971	6.069	82	13,5
1972	14.374	207	14,4
1973	16.018	286	17,9
1974	17.158	639	37,2
1975	48.054	2.114	44,0
1976	49.315	1.158	23,5
1977	34.728	1.234	35,5
1978	31.464	789	25,4
1979	41.421	1.276	30.8
1980	21.655	860	39,7
1981	28.317	1.543	54,5
1982	N.D.	N.D.	N.D.
1983	N.D.	N.D.	N.D.
1984	N.D.	N.D.	N.D.

(Source : MDR par compilation de données de la BCEAO et de la Direction des Statistiques)

N.D. = non disponible.

Quant aux prix moyens, après une baisse régulière jusqu'en 1970, ils étaient fortement en hausse jusqu'en 1975 avant de se stabiliser à une large fourchette allant de 23,5 FCFA/KG à 39,7 FCFA/KG. A partir de 1973, la crise du marché pétrolier a été ressentie sur les importations, dont le rythme de croissance des prix s'est fortement accéléré jusqu'en 1975. Le prix moyen en 1981 (54,5 F/KG) semble imputable aux fluctuations du dollar.

Distribution

Dans l'analyse des statistiques de distribution d'engrais au Sénégal, nous distinguerons deux grandes périodes : celle de la mise en oeuvre du Programme Agricole (P.A.), allant de l'indépendance (1960) à 1980; et celle allant de 1980 à nos jours, caractérisée par l'application de plusieurs modes d'approvisionnement en engrais du monde rural (Cf. tableau n/e2).

Dans le cadre du Programme Agricole

Les performances du système de distribution sont présentées dans le tableau ci-après pour l'ensemble du Sénégal durant les deux décennies du P.A., c'est-à-dire de 1960 à 1970 et de 1971 à 1980.

Années	1960/1970	1971/1980
Distribution moyenne annuelle en tonnes	32.454	64.371

En d'autres termes, la consommation d'engrais a doublé en moyenne d'une décennie à l'autre, témoignant ainsi de la confiance paysanne quant aux effets bénéfiques de l'engrais.

L'examen des données historiques relatives à l'utilisation des engrais permet de distinguer quatre phases :

- de 1961/1962 à 1967/1968 : le volume est en nette progression passant de 14.000 tonnes à 63.000 tonnes ;
- de 1968/1969 à 1970/1971 : on enregistre une chute de la consommation, passée de 63.000 tonnes à 15.000 tonnes avoisinant ainsi le niveau le plus bas (1961/1962) ;
- de 1971/1972 à 1976/1977 : cette période se caractérise par une progression très accentuée qui a permis d'atteindre le tonnage le plus élevé (93.000 tonnes) ;
- de 1976/1977 à 1980/1981 : la consommation d'engrais amorce une nouvelle chute qui s'accentuera en 1980/1981 et en 1981/1982.

L'exploitation de ces données appelle deux remarques :

- Au cours de la période 1961/1966, 85 % du volume d'engrais consommé ont été consacrés à la culture arachidière seulement. Pendant les cinq dernières années du Programme Agricole de 1976 à 1980, la part de l'arachide dans la consommation d'engrais ne représentait plus que 47 %, ce qui correspond à un accroissement des volumes réservés aux autres cultures, des céréales notamment.
- La seconde remarque se rapporte aux fortes variations des volumes d'engrais fixés pour la distribution (surtout à partir de 1976). L'analyse de causes montre que le système de distribution, mis en oeuvre, ne permettait aucunement une

Tableau 2. **Statistiques de Distribution d'Engrais Sous Le P.A.**

	Engrais (tonnes)						
Années	Arachide	Mil-sorgho maïs	Riz	Maraîcher	Coton	Divers	Total
60/61	—	—	—	—	—	—	—
61/62	11.669	1.607	300	356	—	—	13.932
62/63	21.215	2.256	946	375	—	—	24.792
63/64	23.081	2.857	410	252	—	—	26.600
64/65	32.157	4.740	591	288	—	—	37.776
65/66	26.106	4.685	834	310	—	—	31.935
66/67	38.423	9.122	948	522	106	—	42.121
67/68	48.214	12.096	1.381	7,61	312	—	62.764
68/69	25.891	9.645	1.268	492	648	—	37.884
69/70	12.790	8.400	1.975	780	974	—	24.919
70/71	6.490	6.199	494	66	1.574	—	14.822
71/72	12.598	10.482	956	372	2.400	3.105	29.823
72/73	22.426	16.435	882	581	3.301	5.952	49.577
73/74	16.610	10.776	10.291	320	4.889	4.708	47.594
74/75	30.473	24.909	4.324	118	4.027	2	63.853
75/76	36.892	28.201	3.925	784	7.408	673	77.883
76/77	46.859	30.644	6.997	115	7.219	1.482	93.316
77/78	34.249	19.328	3.848	2.086	7.643	78	67.216
78/79	36.700	33.133	4.613	696	8.971	1.595	85.708
79/80	22.900	14.200	3.800	—	6.300	—	47.200
80/81	29.600	26.800	8.300	—	5.100	—	69.800

Source — 1960-1980 Division des Statistiques agricoles/Direction Agriculture
1980-1981 Requête de financement Programme Engrais 1987-1989 — Dakar Juin 1986.

Tableau 3. **Statistiques de Distribution d'Engrais de 1981/82 à 1986/87. (tonnes)**

Speculations Années	Arachide	Mil-sorgho maïs	Riz	Maraîchage	Coton	Divers	Total
1981/82	13.200	14.900	4.200	—	5.800	—	33.100
1982/83	1.500	800	7.300	—	8.500	—	13.100
1983/84	400	1.800	11.700	—	7.500	—	21.400
1985/85	11.000	7.100	12.000	—	8.900	—	39.000
1985/86	13.000	7.100	12.300	—	8.600	—	41.000
1986/87	—	—	—	—	—	—	33.114

Sources : 1981-1985 Requête de Financement Programme Engrais 1987-1989 Dakar Juin 1986
1986-1987 Groupe de Réflexion sur l'Engrais, Rapport final—Propositions pour la relance de la consommation d'engrais au Sénégal, Décembre 1986.

maîtrise des quantités livrées. Il fallait attendre la fin de la commercialisation arachidière pour établir les comptes individuels de chaque coopérative, avant de pouvoir déterminer les capacités d'endettement et de convoquer les Assemblées Générales des coopératives pour évaluer les besoins. Ce processus débutant en Avril, l'ONCAD pouvait alors procéder aux commandes, au transport et à la mise en place avant le démarrage des pluies.

Cette situation expliquait les retards dans la distribution et la dégradation des stocks d'engrais contribuant ainsi à l'augmentation de la charge financière de l'Etat.

L'Après Programme Agricole

A partir de 1980/1981, la distribution totale d'engrais s'était considérablement réduite du fait que la suppression du P.A., s'est avérée un véritable "choc" en milieu paysan.

En effet, cette distribution qui était de 50.000 tonnes en 1980/1981, est tombée à 38.000 tonnes en 1981/1982, puis à 18.000 tonnes en 1982/1983. Après une légère reprise au cours des trois années suivantes, la distribution d'engrais semblait avoir entamé à nouveau une tendance à la baisse (23.000 tonnes en 1986 et 20.000 tonnes en 1987).

De l'analyse du tableau *nf3*, se rapportant aux données statistiques de la distribution d'engrais depuis l'arrêt du P.A., se dégagent les observations suivantes :

- Après la suppression du P.A., la chute de la distribution reste si marquée, que le volume d'engrais le plus élevé mis en place, (41.000 tonnes en 1985/1986), n'atteint même pas le plus faible niveau de distribution, remarqué lors des neuf dernières années de la mise en oeuvre du P.A.
- malgré l'arrêt du P.A., la part d'engrais allouée aux cultures de coton et de riz n'a cessé de croître et a atteint des niveaux records au cours des trois dernières années.

En d'autres termes, la chute de la distribution d'engrais, après l'arrêt du P.A., s'est produite au détriment des cultures de mil/sorgho et de l'arachide.

Promotion

De 1962 (date de création de la SIES) à 1984 (date de la fusion SIES/ICS), la commercialisation des engrais était assurée par la SSEPC. A compter de 1984, la SENCHIM, filiale des ICS, assure la commercialisation des engrais à l'exportation et sur le marché local.

La chronique des ventes, exprimées en volume, entre 1967 et 1987, est présentée au tableau *nfe* 4.

L'examen du tableau 4, se rapportant à l'évolution des ventes à l'exportation et sur le marché intérieur, permet de remarquer que, de 1967 à 1987, le volume annuel moyen des ventes d'engrais s'élevait à 70.000 tonnes environ, (dont 40.000 tonnes écoulées sur le marché local et 30.000 tonnes exportées). La chronique des ventes se caractérise par de

Tableau 4. **Evolution Des Ventes Sur Le Marché Interieur Et A L'Exportation (unité : tonnes)**

Années	Ventes locales	Exportations	Total ventes	Productions
1967	15.000	5.000	20.000	24.200
1968	49.000	16.000	65.000	75.700
1969	60.200	17.000	78.000	88.500
1970	33.500	43.000	77.000	68.700
1971	30.000	30.000	60.000	76.800
1972	31.000	35.900	67.000	60.600
1973	55.500	39.500	93.000	93.600
1974	84.000	29.000	113.000	113.500
1975	81.000	18.000	99.000	60.100
1976	60.000	30.000	90.000	97.800
1977	87.000	28.000	115.000	107.700
1978	65.000	34.000	99.000	79.400
1979	57.000	40.000	97.000	94.200
1980	38.000	37.000	75.000	66.600
1981	12.000	31.000	43.000	65.800
1982	16.000	2.500	41.000	48.100
1983[1]	16.000	24.000	40.000	24.200
1984	10.800	34.400	45.200	
1985	27.500	59.700	87.700	
1986	14.600	27.100	41.700	
1987[2]	13.100	60.500	73.600	

[1]de 1967 à 1983 : ventes par SSEPC
de 1984 à 1987 : ventes par SENCHIM

[2]10 premiers mois ce l'année,

fortes fluctuations annuelles avec un minimum de 20.000 tonnes en 1967 et un maximum de 115.000 tonnes en 1977. Cette forte variation est provoquée par la grande irrégularité des ventes locales, (le volume oscille entre 10.000 et 87.000 tonnes) et, en moindre mesure, par la variation des quantités exportées qui, excepté durant les années de démarrage, ont été de 18.000 tonnes pour le niveau le plus bas et 68.000 tonnes pour le niveau maximum.

Cependant, nous pouvons distinguer deux phases dans l'analyse de l'évolution de la promotion des engrais :

- les ventes effectuées par la SSEPC, de 1967 à 1983 et celles réalisées par la SENCHIM pour la même période.

Ventes de la SSEPC

Elles peuvent être subdivisées en trois périodes :

- la première de 1967 à 1972, au cours de laquelle, la demande intérieure s'est située autour de 36.000 tonnes en moyenne annuelle, soit un écart de 24.000 tonnes par rapport au niveau prévisionnel de 60.000 tonnes ; les exportations, avec un niveau annuel moyen de 25.000 tonnes, ont compensé ce faible volume, permettant ainsi à la SSEPC de réaliser un volume de ventes de 61.000 tonnes par an.
- la deuxième de 1973 à 1980, durant laquelle la consommation nationale d'engrais a augmenté de manière significative, avec un niveau annuel moyen de l'ordre de 70.000 tonnes ; les exportations ont également progressé, mais dans une proportion moindre. Durant ces huit années, le volume global moyen des ventes a été de l'ordre de 100.000 tonnes, approchant ainsi la capacité minimale de production de la SIES.
- quant à la troisième période, se définissant après l'arrêt du P.A. (à partir de 1981), le marché intérieur a fléchi de manière importante, avec un volume moyen de l'ordre de 15.000 tonnes entre 1981 et 1983 ; parallèlement, les exportations ont, elles aussi, subi une régression passant de 32.000 tonnes en moyenne annuelle (1973/1980) à 26.000 tonnes environ.

Ventes par la SENCHIM

Durant la période 1984/1987, le niveau annuel moyen des ventes d'engrais s'est situé aux environs de 62.000 tonnes, marquant ainsi un net redémarrage des activités par rapport aux années 1981/1983. Cependant, ce volume annuel moyen est conforté par les exportations contribuant pour plus de 72 % du volume global de vente (45.000 tonnes), alors que la demande nationale se situe approximativement à 16.000 tonnes, soit un niveau comparable à celui enregistré entre 1981/1983.

La vente d'engrais produits localement porte sur quatre produits : le DAP, le TSP, le SSP et les engrais ternaires (Cf. Tableau n/5).

De l'analyse de ce tableau, nous remarquons que le DAP, le TSP et le SSP sont des engrais essentiellement destinés à l'exportation, alors que les ternaires, eux, représentent près de 90 % des ventes locales. Au cours des deux dernières années, des volumes non négligeables de ces types d'engrais ont fait l'objet d'exportation.-Durant la période 1984/1987, les valeurs des ventes à l'exportation et sur le marché local variaient entre 8 milliards et 3,5 milliards de FCFA environ .

Pour l'année 1987 (10 premiers mois), alors que le volume des ventes approchait le maximum réalisé en 1985, (respectivement 74.000 et 87.000 tonnes), le chiffre d'affaires représentait, quant à lui, 42 % seulement de celui réalisé en 1985 ; ceci s'explique par la modification structurelle de la composition des ventes. En effet, le DAP, qui représentait plus de 50 % des ventes en 1985, a été supplanté par le NPK en 1987, (80 % des ventes), dont la valeur marchande est environ 50 % moins élevée que celle de DAP .

Environ 70 % du chiffre d'affaires est réalisé par des recettes d'exportations (3,3 milliards en moyenne pour la période 1984/1987), alors que les ventes locales ne représentent que 30 % environ (1,4 milliard de FCFA en moyenne). Cette situation est due au fait que les productions de DAP et de TSP des ICS se vendent à l'exportation à un prix sensiblement supérieur aux cours mondiaux-(l'écart de prix pour le DAP varie de 30 à 40 dollars US/tonne, alors que pour le TSP, il avoisine les 60 dollars US/tonne)-Ajoutons, cependant, qu'il s'agit d'une simple tendance établie sur la base des prix à l'exportation correspondant à des catégories d'engrais bien précises, pour une base FOB Floride ; mais, les écarts de prix sont tels, qu'il est permis de penser que la SENCHIM valorise au mieux les produits qu'elle exporte .

Pour les ternaires, les prix à l'exportation, exprimés en dollars courants, sont inférieurs deux années sur quatre sur le marché local, mais ceci est vraisemblablement dû à des différences de formulation.

Cette préférence pour l'exportation se remarque dans le système de prix exprimé en FCFA (Cf. Tableau 6).

La Politique de Crédit et De Subvention des Engrais

Depuis l'indépendance en 1990, le Sénégal a connu les trois systèmes de distribution de l'engrais ci-après :

- le crédit coopératif à prix subventionné ;
- la retenue à la source sur le prix aux producteurs d'arachide, avec subvention du prix de cession de l'engrais ;
- la vente au comptant à prix subventionné.

Le premier système existait avant le "Programme d'justement", tandis que les deux autres ont vu le jour avec ce programme.

Le Crédit Coopératif à Prix subventionné (1960-1980)

Ce système a été institué dans le cadre d'une politique globale de crédit agricole appelée le "Programme Agricole" (P.A.), pour les facteurs de production que l'Etat sénégalais voulait promouvoir.

Cette politique mettait en jeu trois partenaires : la BNDS, qui finançait le crédit, l'ONCAD qui exécutait la politique de crédit et les coopératives qui bénéficiaient de ce crédit.

Les prix de rétrocession de l'engrais aux producteurs étaient extrêmement bas et la fourniture était effectuée à crédit, avec remboursement par prélèvement sur la valeur de

Tableau 5. Analyse Des Ventes Senchim

Produits	1984		1985		1986		1987[1]	
	Q	V	Q	V	Q	V	Q	V
DAP								
Export[2]	17.826	1.670	43111	4300	3875	361	11595	678
Local	820	130	2275	260	2702	270	662	53
Total	18.646	1.800	45386	4560	6577	631	12257	731
TSP								
Expert	7.711	442	5142	428	2145	155	1325	78
Local	72	7	459	35	1336	104	715	53
Total	7.783	449	5601	463	3481	259	2040	131
SSP								
Export	4656	181	7120	286	659	31	800	28
Local	–	–	190	10	27	2	27	2
Total	4656	181	7310	296	686	33	827	30
Engrais ternaires								
Export	4175	439	4361	457	20462	1548	48856	1923
Local	9965	1025	24605	2223	10501	943	11678	626
Total	14140	1464	28966	2680	30963	2491	58534	2549
Total								
Export	34368	2732	59734	5471	27141	2095	60576	2707
Local	10857	1162	27529	2528	14566	1319	13082	734
Total General	45225	3894	87263	7999	41707	3414	73658	3441

Unités: Q en tonne
V en millions FCFA.

[1]10 premiers mois
[2]valeur export FOB Dakar

la récolte pendant la période de traite des cultures de vente.

Ce système, qui a suscité en milieu rural une demande croissante (voir chap. distribution), a été cependant abandonné par l'Etat pour diverses raisons :

- la BNDS a eu de sérieux problèmes de recouvrement du crédit consenti aux coopératives par l'intermédiaire de l'ONCAD ;
- l'ONCAD, depuis sa fusion avec les CRAD en 1970, a eu à faire face à des difficultés de gestion de stocks, liées aux brusques variations annuelles des quantités d'engrais à mettre à la disposition des coopérateurs ;
- l'ONCAD maîtrisait difficilement la situation de l'endettement coopératif, qui constituait un grand malaise social quant à l'identification des débiteurs ;
- les coopérateurs accusaient l'ONCAD de surestimer l'encours de leurs dettes, de même qu'ils profitaient des mauvais hivernages pour ne pas payer les dettes contractées.

Ainsi, ni la BNDS, ni l'ONCAD, ni les coopératives ne trouvaient satisfaction dans ce système de crédit engrais du P.A.

Les systèmes de distribution de l'engrais sous le "Programmed'Ajustement"

Ces systèmes voient le jour avec la dissolution de l'ONCAD et la suppression du P.A. en 1980. La SONAR est alors créée pour exécuter le programme "Facteurs de Production".

Cette nouvelle politique, préconisée par l'Etat sénégalais, arrêtait alors certaines mesures suivantes :

- En 1980/1981, vente de l'engrais avec subvention au prix de 25 FCFA au lieu de 80 FCFA, prix usine ;
- en 1981/1982, en plus du prix subventionné de l'engrais à 25 FCFA, l'Etat opérait une retenue de 2 FCFA/KG sur le prix aux producteurs d'arachide ; c'est ainsi que le financement de l'engrais pour une campagne au niveau de la production dépendait de l'année précédente.
- En 1982/1983, vente de l'engrais au comptant, en maintenant les prix subventionnés à 25 FCFA/KG au lieu de 110 FCFA/KG prix usine. En effet, ce nouveau système était en rupture totale avec les deux premiers car l'investissement "engrais" devait être déduit

Tableau 6. **Prix Unitaire Des Engrais En Valeur Courante**

	Marché Mondial[1]	Senchim	
	$ tonne	$ tonne	(F/CFA/kg)
DAP			
1984	189	210	96,5
1985	169	230	100,5
1986	150	258	55,9
1987	167	181	59,7
TSP			
1984	131	125	57,7
1985	121	182	82,7
1986	110	193	74,4
1987	130	194	64,0
SSP			
1984		89	38,8
1985		92	40,4
1986		131	47,9
1987		109,7	36,2
NPK Export			
1984		240	105,1
1985		241	104,9
1986		209	75,7
1987		154,6	51,0
NPK Senegal			
1984		232	108,1
1985		197	90,4
1986		235	79,8
1987		162	52,6

[1]Source : Banque Mondiale : Commodity Prices.

directement du revenu monétaire paysan de la campagne écoulée et non plus d'une hypothèse sur la production future.

- En 1983/1984 et 1984/1985, rétablissement du système de retenue à la source de 2 FCFA à 5 FCFA et vente de l'engrais au prix subventionné de 50 FCFA au lieu de 134 FCFA prix usine.
- En 1985/1986, abandon de la retenue à la source (apparition du "commerce parallèle " des arachides en 1984/1985) et vente au comptant de l'engrais au prix subventionné de 50 FCFA.
- en 1986/1987, 1987/1988, 1988/1989, institution de la subvention dégressive sur trois ans, financée par l'USAID et respectivement de 24 FCFA, 16 FCFA et 8 FCFA.

Cette nouvelle politique d'approvisionnement du monde rural en engrais est aussi caractérisée par un désengagement de l'Etat (la NPA et la Politique d'Engrais). A travers cette politique, l'Etat voudrait résoudre :

- le problème du financement du Programme Engrais soit directement, à partir de la filière arachidière avec une retenue sur les prix aux producteurs, soit indirectement à partir du revenu monétaire individuel de chaque coopérateur, pour chaque campagne, avec établissement de la vente au comptant ;
- substituer la subvention des prix de cession de l'engrais, à partir du Trésor Public, par une subvention de l'USAID et de la Caisse Centrale ; augmenter le prix de cession de l'engrais pendant cette période de substitution.

Ces décisions sont conjuguées avec la décision de privatisation, par l'encouragement des privés (O.P.S., commerçants, groupements des producteurs, sections villageoises) à occuper le système de distribution laissé par la SONAR dissoute.

Ce fut une rupture totale avec le système étatique de distribution en vigueur depuis l'indépendance.

La Problématique De La Demande D'Engrais

L'examen des statistiques de distribution d'engrais a fait apparaître que les quantités d'engrais utilisées de 1960 à 1980 ont beaucoup progressé, mais que cette progression a subi d'importantes fluctuations d'une année à l'autre.

Parmi les facteurs importants d'influence sur le niveau de la demande d'engrais, nous retenons :

- le prix de vente de l'engrais ;
- le niveau de subvention et de crédits ;
- la vulgarisation ;
- la recherche agricole.

Le prix de vente

Le tableau 7 présente le prix de cession des engrais de 1971/1972 à 1984/1985, et son examen permet d'aboutir aux constatations suivantes :

- les engrais sont rétrocédés aux producteurs à un prix unique au kilo, quelque soit leur composition, et malgré le fait que leurs coûts réels peuvent varier dans des proportions élevées ; c'est ainsi que sur la multitude de formules destinées a l'arachide, au mil et au riz, le prix reste le même sauf pour l'urée et le 10.10.20 (Cf. tableau 8).
- Le prix de cession a été progressivement relevé passant de 12 FCFA/KG en 1971/1972 à 50 FCFA/KG en 1983/1984.
- l'Etat appliqua la vérité des prix en 1984/1985 et c'est ainsi que le kilo de l'Urée passa de 45 FCFA à 91 FCFA et celui du 18.46.0 de 56 FCFA à 134 FCFA (périmètres irrigués du Fleuve).

Durant la campagne 1986/1987, les prix de revient au producteur (transport + commercialisation) étaient : 60 FCFA/kg pour l'urée et 91 FCFA/KG pour les engrais complexes.

En ce qui concerne la campagne 1987/1988, les prix ont été définis par formule et par région en prenant compte des coûts de transports, de la subvention à 16 F/KG et des marges incitatives accordées aux grossistes et détaillants (Cf. tableau 9). Cependant, les prix pratiqués par les SRDR ont été inférieurs aux prix préconisés, rendant ainsi les opérateurs privés potentiels hésitants à l'égard de la filière.

Tableau 7. **Prix Engrais De 1971 à 1983 En F CFA/kg**

Prix Années	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Prix de cession des engrais F CFA/kg	12	12	16	16	20	25	25	25	25	25	25	25	50	—
Prix de l'arachide (F CFA/kg)	23,1	23,1	29,5	41,5	41,5	41,5	41,5	41,5	45,5	50	70	70	70	90
Prix du Mil/Sorgho (F CRFA/kg)	17	17	25	30	30	35	35	40	40	40	56	50	55	70

Tableau 8. **Prix Engrais—P.A. (1977/1978)**

Désignation	Prix de rétrocession	Prix de vente au comptant
Engrais—Arachide		
.6.20.10	25	24
.5.20.08	25	24
.10.10.08	25	24
.63.0.42	25	24
.6.10.20	25	24
.8.18.27	25	24
.10.20.08	25	24
Engrais—mil		
.0.45.0	25	24
.40.48.0	25	24
14.7.7	25	24
10.18.10	25	24
10.21.21	25	24
.8.14.18	25	24
Engrais—riz		
.7.21.29	25	24
.4.17.24	25	24
16.48.0	25	24
13.5 . 13.3 . 0	25	24
Sulfate d'ammoniaque	25	24
TSP	25	24
Chlorure de potasse	25	24
Urée et perlurée 46 % N	35	34
Engrais Maraicher + Tomate		
Gypse	4.98	4
10.10.20	40	38
Engrais fruitier		
Filler	7.26	7
Chaux magnésium	25	24
Sulfate de potasse	25	24

Le niveau de subvention et des crédits

Il est certain que le mécanisme simultané de crédit et de subvention a été la cause essentielle de l'accroissement de la demande d'engrais. Environ 24,5 milliards ont été consacrés à la subvention de l'engrais durant le P.A. (Cf. tableau 10).

Les subventions de l'engrais ont permis une politique à bas prix : 12 FCFA/KG en 1971, 16 FCFA/KG en 1973, 20 FCFA/KG en 1975, 25 FCFA/KG de 1976 à 1982 et 50 FCFA/KG en 1983.

Le système de subvention a tout de même permis une importante utilisation d'engrais dans le monde rural.

Avec l'application de la subvention dégressive à partir de 1986/1987, (suite à la faible demande d'engrais pendant les deux campagnes de 1984/1985 et de 1985/1986 et du fait de la libéralisation des prix de l'engrais), on remarque à partir de la première année, qu'une impulsion dans la demande d'engrais utilisés n'a pas été réalisée. En effet, le volume d'engrais utilisé a fortement baissé, démontrant ainsi que la subvention seule ne suffisait pas à assurer une augmentation de la distribution.

Quant au crédit, dont le remboursement se faisait par prélèvements sur la valeur de la récolte en période de traite des cultures de rentes, il a été suspendu par l'Etat pour les raisons suivantes :

- entre 1970 et 1980, le taux de recouvrement moyen des crédits, à court terme et à long terme du P.A., au niveau national, a été de 60 %, obligeant les autorités à effacer les arriérés de dettes. Les impayés entrent dans la dette ONCAD que l'Etat continue d'honorer encore jusqu'à maintenant ;
- la lourdeur pour le Trésor Public de fonds nécessaires à la mise en place des crédits-engrais (O,33 à 6,5 milliards/an).

Utilisation des Intrants Complémentaires

Engrais chimiques naturels

Le phosphate produit au Sénégal appartient aux types de phosphate d'aluminium (29,5 % et 28,5 % de P205), de phosphate de chaux, de phosphate de concentré marchand (37,5 % de P205 et 78 % BPC) appelé phosphate naturel et utilisé par les ICS pour la production d'acide phosphorique à 54 % de P205.

Il faut noter que les ICS utilisent aussi les particules de phosphate trop fines pour la commercialisation (les SCHLAMMS), de même que le phosphosypse (1 million de tonnes de rejets/an), à forte proportion de SO4C4, éventuellement utilisé comme amendement agricole sur les terres salées sodiques.

Le phosphate de la région sénégalaise de Matam (28,5 % de P2O5) peut être utilisé directement.

Des amendements calciques sont disponibles sur le territoire sénégalais et il s'agit en particulier du silicate de chaux (54 % Ca0), de coquilles broyées, de chaux magnésienne (45 %

Tableau 9. **Prix Maxima De Vente Des Engrais Au Producteur Par Formule Et Par Région**

Régions	Distances (km)	Formules 6.20.10	8.18.27	10.10.20	14.7.7	16.46.0 (DAP)
Usine I.C.S.	0	61 931	79 066	75 000	64 184	80 000
Saint-Louis	270	65 352	87 114	81 950	68 214	80 300
Kaolack	189	63 246	85 008	79 844	66 108	86 194
Fatick	145	62 102	83 864	78 700	64 964	85 050
Tamba	490	71 072	92 834	87 670	73 934	94 020
Kolda	675	75 882	97 644	92 480	78 744	98 830
Ziguinchor	440	69 772	91 534	86 370	72 634	93 100
Thies + Dakar	146	60 152	81 914	76 750	63 014	83 100
Diourbel	146	62 128	83 820	78 726	64 990	85 076
Louga	200	63 532	85 294	80 130	66 394	86 480

Unité : F CFA
Prix au 27 janvier

CaO), de calcaires phosphatés (26 % Cao), et de chaux agricole (70 % CaO).

Comme amendement organique, des études sont en cours sur un produit découvert en 1981. Il s'agit de la tourbe faisant actuellement l'objet d'études centrées sur l'utilisation agricole. Le but visé est d'amender, en matière organique, les sols pauvres des zones cultivables proches de gisements, en vue d'accroître leurs rendements, le pouvoir de rétention en eau des sols et de faciliter la solubilisation des phosphates naturels.

Vulgarisation

Cette année, la campagne de publicité était axée sur les modalités d'acquisition, sur les prix maxima par région, sur la subvention et sur le retour aux anciennes formules.

La radio, avec 20 émissions en français et en 6 langues nationales, l'édition de brochures de 2 types pour les paysans, (avec 1 dépliant pour les prix régionalisés et l'autre pour chaque type de culture), furent les supports de l'information.

Les messages publicitaires, livrés aux commerçants, aux sections villageoises et aux coopératives, insistaient sur les marges bénéficiaires intéressantes pour encourager les agriculteurs à investir dans l'engrais. Certes, cette démarche peut inciter ces opérateurs économiques à investir dans la distribution et dans la commercialisation des engrais, mais il s'agira surtout de convaincre les producteurs des réelles possibilités d'amélioration du ratio "bénéfice/coût".

Recherche Agricole

L'ISRA (Institut Sénégalais de Recherches Agronomiques) est chargé des études en matière de Recherches Agronomiques au Sénégal, sous la tutelle du Ministère du Développement Rural. Sous sa direction, fonctionne le Centre National de Recherches Agronomiques de Bambey (CNRA) avec des sous-stations à Nioro, Sinthiou Malème, Louga et Darou. D'autres stations de recherches se trouvent à Sefa, Djibélor et Richard-Toll.

Les premières études sur la fertilisation minérale étaient

Tableau 10. **Evolution Des Charges Du P.A. En Engrais**

Campagne agricole	Valeurs (en millions de FCFA) Montant à payer par les paysans	Montant subventionné par l'Etat	Total
1965/66	372,8	326,8	702,6
1966/67	609,0	470,3	1079,3
1967/68	828,1	557,7	1358,7
1968/69	405,8	367,4	818,2
1969/70	273,7	131,7	405,4
1970/71	159,6	171,4	331,0
1971/72	413,0	286,5	699,5
1972/73	550,2	991,9	1542,1
1973/74	528,3	869,5	1397,6
1974/75	528,1	949,0	1377,1
1975/76	1560,3	4906,4	6466,7
1976/77	2356,1	3827,8	6183,9
1977/78	1764,1	2143,2	3907,3
1978/79	2519,6	2811,5	5331,1
1979/80	1462,4	1679,1	3141,5
1980/81	2513,9	4028,5	6542,4
—	—	24528,7	—

(Source : Etude Politique Agricole/Sénégal (1985)—USAID.

axées sur l'arachide et les céréales de même type. Elles ont permis la définition de formules NPKS, très peu concentrées, pouvant accroître de façon significative et à faibles coûts la production agricole, et de familiariser le paysan sénégalais à l'utilisation des engrais minéraux.

Plusieurs formules, tenant compte des situations écologiques et des caractéristiques des sols, avaient été définies pour l'arachide, alors que pour le mil et le sorgho, une formule unique était établie. Sous l'impulsion de cette politique, la demande en engrais s'est accrue notamment à partir de 1961 pour atteindre en 1967, une production d'arachide et de mil de 60.000 tonnes.

Face à la réduction des jachères (voire leur disparition totale), à la non-restitution des résidus des récoltes et à

l'accentuation du déséquilibre minéral, une recherche sur la fertilisation minérale a été définie à partir de 1972. Cette recherche visait trois niveaux d'intensification :

- le niveau F0 : fertilisation légère pour les systèmes de cultures qui ne sont pas ou très faiblement mécanisés ;
- le niveau F1 : (semi-intensif) fumure minérale forte pour les systèmes de cultures semi-mécanisés ;
- le niveau F2 : (intensif) : fertilisation forte pour les systèmes de cultures mécanisés avec application.

Les principaux résultats de la fertilisation minérale des cultures pluviales

Les premières études, débutées en 1937 et axées uniquement sur le facteur engrais dans le but d'augmenter les rendements, ont tout d'abord abouti à une fertilisation dite "légère" à partir de 1961. Elles préconisaient pour les céréales (mil et sorgho) une seule formule à dominance azotée : 14-7-7 et pour les arachides (Cf. Tableau ci-dessous).

ZONES	FORMULES	DOSES (Kgs/ha)
LOUGA	12-10-10 + 12 S	150
TIVAOUANE	10-14-8 + 10 S	150
THIES	10-0-30 + 10 S	150
BAMBEY-DIOURBEL	6-20-10 + 8 S	150
SINE-SALOUM	6-20-10 + 8 S	150
TAMBACOUNDA	6-20-10 + 8 S	150
CASAMANCE	2-28-10 + 10 S	150

Cette proposition avait été modifiée conduisant aux points suivants :

- renforcement de la fertilisation phosphatée par rapport aux autres éléments, tenant compte de la carence des sols érodés sénégalais ;
- pratique de la jachère pour limiter, voire empêcher, la baisse du statut potassique du sol, vu que les doses de potassium étaient insuffisantes par rapport aux besoins de l'arachide.

En plus de cette fertilisation légère, la recherche a abouti à une fertilisation à trois niveaux afin d'amener progressivement les paysans à appliquer les fumures, à condition qu'ils puissent mettre en oeuvre l'ensemble des techniques culturales définies pour chaque stade. En effet, ces derniers, avec des moyens ne leur permettant pas de passer à la fertilisation moyenne ou forte, et aidés par l'achat par le prix unique appliqué aux engrais NPK dans le pays, ont utilisé des formules d'engrais concentrées (8-18-27, 10-21-21).

Des études sur la dynamique de pénétration et d'application en milieu rural des thèmes définis, menées au Sud du Sine-Saloum (1968) et dans les régions de Thiés et Diourbel (1970), ont révélé les anomalies suivantes par suite de contraintes diverses s'exerçant dans ces milieux :

- Le labour de début cycle n'était en général pas effectué ;
- les rotations céréales /légumineuses n'était pas toujours suivies ;
- les doses d'engrais appliquées étaient nettement inférieures à celle recommandées (40-50 % de celles-ci) ;
- l'amendement calcique n'était pas appliqué ;
- les restitutions organiques n'étaient faites que sur le champs de case par parcage ou par divers résidus provenant du ménage et des cultures de case.

L'étude des bilans minéraux a mis en évidence un important déficit en K (exportation par les pailles), Ca et Mg.

Quant aux travaux sur la fertilisation potassique de l'arachide, et du mil, il ressort que :

- les effets de cette fumure ne sont significatifs qu'aux cours de la troisième année ;
- la réponse de l'arachide en K dépend plus de la pluviométrie que de celle du mil; elle est faible, voire nulle en année sèche, contrairement à celle du mil ;
- dans la zone central du Nord, une fumure phospho-azotée est suffisante pour un objectif de production d'une tonne/ha de mil en grain. Avec un objectif supérieur ou égal à 2 T/ha, l'apport de K devient nécessaire (il faut alors 30 kgs de K2O/ha) ;
- la fumure potassique sans restitution des pailles de mil ou d'apports de matière organique, provoque un bilan potassique du système arachide-mil déficitaire, avec une diminution très nette des différentes formes du K du sol (total mobilisable et échangeable).

Les Principaux Résultats sur les Amendements en Culture Pluviales

Le phosphate de fond, recommandé après plusieurs travaux réalisés sur les phosphates naturels (tricalcique de Taïba brut et broyé, phosphal, baylifos, Schlams, scories, phosphogypses etc...) consiste, la première année, à l'apport de la mise en culture pour F1 et F2 de 400 kgs/ha de tricalcique de Taïba (37 % de P205) et de 1.000 kgs/ha pour les cultures en submersion.

Ce système de fertilisation, dans le but de corriger la carence initiale en P quasi générale des sols du Sénégal, se faisait gratuitement pour les paysans, à condition de mettre en application les thèmes techniques. Cependant, il faut signaler qu'à l'heure actuelle, les surfaces amendées restent très faibles.

Depuis 1960, les travaux de recherche menés sur les amendements calciques visaient à examiner les effets du calcium sur la neutralisation de l'acidité des sols, sur l'alimentation calcique des plantes et sur les rendements des cultures. Les résultats de ces travaux de recherche n'ont pas été largement diffusés en milieu rural.

A partir d'une estimation faite en 1971-1973, il résulte que 43.000 ha nécessitaient un chaulage immédiat dans les régions les plus affectées du pays, notamment les régions de Thiés-Diourbel (25 %) et de Casamance continentale (50 %).

Les produits testés pour le chaulage sont :

- le silicate de chaux ou ciment Sococim (54 % Cao),
- les coquilles broyées,
- la chaux magnésienne (45 % Cao),
- le phosphogypse (25 % Cao),
- la chaux agricole (76 % Cao).

Les conclusions tirées des travaux sur le chaulage peuvent être résumées ainsi :

- l'amendement calcique est attribué pour des sols avec un pH inférieur à 5,5 ;
- la chaux agricole est la plus efficace,
- l'amendement calcique est efficace pour l'arachide et le coton avec des effets significatifs sur les rendements ;
- l'apport combiné Ca et K améliore l'efficacité du chaulage et l'utilisation du K sur le coton.

L'apport de chaux (70 % Cao) de 200 kgs/ha environ permet de corriger l'acidité des principaux sols concernés. Il faut remarquer, par contre, que la stabilisation du pH corrigé est difficile, voire impossible à réaliser, sans apport de matières organiques (fumier, compost) et cela à cause du faible pouvoir tampon des sols ; d'où le besoin de chaulage tous les deux ans, car après cette période, le pH du sol corrigé diminue notablement tendant ainsi vers sa valeur initiale.

Les amendements organiques, pour l'amélioration ou le maintien du statut organique des sols, sont de deux sortes :

- Enfouissement de jachère, d'engrais vert cultivé et de pailles de céréales après les récoltes : malgré un accroissement du rendement de 40 à 80 % pour le sorgho, le mil et le maïs, (en expérimentation), cette technique n'est pas passée au niveau des paysans.
- L'apport de matière organique plus ou moins évoluée (fumier, compost) : des effets très positifs sur les caractéristiques chimiques, la teneur en matière organique et le pH des sols sont remarqués et cet apport procure des accroissements importants (augmentation de 80 à 100 %).

La Fertilisation Minérale des Cultures Pluviales à Moindre Coût

L'analyse de l'évolution de la consommation des engrais dans le monde rural, suivie régulièrement par la recherche, a montré à partir de 1976 une tendance à la diminution, qui s'est accentuée par la suite en 1980. Cette situation a renforcé la nécessité de la recherche sur des sources d'éléments fertilisants moins coûteuses et sur l'étude des techniques culturales, susceptibles de réduire les différentes pertes minérales et d'accroître la fixation symbiotique de l'azote atmosphérique par les légumineuses.

Signalons que dès le début des recherches sur la mise au point des formules de fertilisation, une attention avait été accordée à l'utilisation des sources fertilisantes à moindre coût. C'est ainsi, qu'à partir des études sur l'incorporation des engrais NPK, la fabrication des types d'engrais suivants a été obtenue :

- la 6.20.10 dont 50 % de la teneur proviennent du P ;
- la 8.18 27 dont le P provenant du Phosphal représente 10 % de son taux en P2O5.

Promotion et Fixation des Prix des Produits Agricoles

L'analyse comparative des prix intérieurs pour les principaux produits agricoles commercialisés (arachide, coton, mil sorgho et tomate industrielle) par rapport au prix de cession des engrais (unique quelles que soient la formule et la région), permet de faire le rapport entre les prix de chaque produit et le prix de l'engrais. Ce rapport est très significatif, car il permet de mesurer les termes de l'échange intérieur, c'est-à-dire le nombre de kilos d'engrais permettant d'acheter un kilo de chacun des produits (voir les tableaux 11, 12, 13, 14).

Ce rapport permet de constater par sa variation :

- deux périodes fastes qui auraient dû encourager l'utilisation d'engrais (par exemple, pour l'arachide en 1974 et en 1975, puis en 1981 et en 1982 ; pour le coton de 1965 à 1975 et de 1979 à 1982 ; pour la tomate, jusqu'en 1982 ; pour le mil en 1981 et en 1982).
- des périodes, où ce rapport décourage l'utilisation d'engrais (par exemple, pour l'arachide, le mil et la tomate depuis 1983 ; pour le coton de 1976 à 1978 et surtout en 1983).

Il n'est donc pas étonnant, que l'utilisation d'engrais, avec l'application de la politique des prix en réalité ait connu ces dernières années, une diminution très importante. Cependant, on ne peut affirmer qu'il existe une corrélation pour les années antérieures à 1983. Il est vrai que pour cette période, le facteur "modalités de distribution" interférait fortement avec celui du "prix de cession".

Perspectives Du Secteur Engrais

Depuis la suppression du P.A. (en août 1980), le gouvernement a entrepris la réorganisation de sa politique d'engrais dans le cadre du "programme " de Redressement Economique et Financier" (PREF 1980/1985). Les premières orientations stratégiques ont été complétées par la "Lettre de Politique de Développement n/e 1", puis dans le cadre du "Programme d'Ajustement à Moyen et Long Termes" (PAMLT 1985/1992), par la N.P.A. (Nouvelle Politique Agricole) et par la "Lettre de Politique de Développement n/C 2".

Ces changements sont conjugués avec la décision de privatisation de la commercialisation des engrais, en encourageant les privés à occuper le système de distribution. Les changements ont pour caractéristique principale, la libéralisation des importations de l'urée à compter de 1986 et des engrais complexes à partir de 1989 (dernière année de mise en application de la subvention dégressive).

Malheureusement, les changements de politique n'ont pas encore réussi à relancer la demande d'engrais par le monde rural, ni à régler les problèmes de distribution et de financement annuel d'un programme d'engrais. Les deux années de libéralisation du marché de l'engrais n'ont ni empêché la hausse du prix de cession de l'engrais au producteur, ni permis d'attirer dans le circuit un nombre adéquat de privés, ni de relancer la consommation d'engrais.

Ainsi, pour les deux dernières campagnes (1986/1988), le bilan se résume comme suit :

- **Bilan de la Campagne 1986/1987**

D'une manière générale, l'utilisation des engrais durant cette campagne a fortement baissé. Sur un tonnage global de 35.583 tonnes, toutes formules confondues, 23.114

Tableau 11. **Evolution Comparée Des Prix Au Producteur D'Arachide D'Huilerie, De L'Engrais Et Des Quantités Produites Et Utilisées**

Campagne	Prix engrais F.CFA/kg	Quantités engrais Utilisées (t)	Prix arachide F.CFA/kg	Rapport prix Arachide/eng.	Quantités arachides produites (t)
1965/66	12	26.106	21.5	1.79	1.122.100
1966/67	12	38.423	20.5	1.7	857.100
1967/68	13	48.214	18	1.38	1.005.200
1968/69	12	25.891	18	1.5	819.500
1969/70	11	12.790	18.5	1.68	788.800
1970/71	11	6.490	19.5	1.77	582.000
1971/72	12	12.598	23.1	1.92	985.394
1972/73	12	22.426	23.1	1.92	570.010
1973/74	16	16.610	29.5	1.84	657.026
1974/75	16	30.473	41.5	2.59	980.727
1975/76	20	36.892	41.5	2.07	454.147
1976/77	25	46.359	41.5	1.66	1.106.322
1977/78	25	34.247	41.5	1.66	508.097
1978/79	25	36.700	41.5	1.66	1.050.641
1979/80	25	22.915	45.5	1.82	672.886
1980/81	25	23.595	50	2.0	521.386
1981/82	25	16.250	60	2.4	866.624
1982/83	25	1.500	60	2.4	1.145.401
1983/84	50	1.200	60	1.2	539.174
1984/85	90	8.920	80	0.88	490.000
1985/86	105	5.075	90	0.86	590.460
1986/87	64	7.085	90	1.4	821.830
1987/88	N.D.	—	90	N.D.	853.300

N.D. : Donnée non disponible

Tableau 12. **Evolution Comparée Des Prix Au Producteur Du Coton Et De L'Engrais Et Des Quantités Produites Et Utilisées**

Campagne	Prix engrais F.CFA/kg	Quantités engrais Utilisées (t)	Prix coton F.CFA/kg	Rapport prix coton/engrais	Quantités de coton produites (t)
1965/66	12	N.D.	33	2.75	268
1966/67	12	N.D.	33	2.75	1.146
1967/68	13	N.D.	33	2.53	3.991
1968/69	12	N.D.	28	2.33	9.889
1969/70	11	N.D.	28	2.54	11.500
1970/71	11	1.574	30	2.72	11.843
1971/72	12	2.441	30	2.5	21.547
1972/73	12	2.796	31	2.58	23.461
1973/74	16	4.830	34	2.12	33.077
1974/75	16	5.676	42	2.62	42.099
1975/76	20	6.943	47	2.35	30.685
1976/77	25	6.495	49	1.95	45.207
1977/78	25	8.932	49	1.95	37.166
1978/79	25	8.960	49	1.95	33.805
1979/80	25	6.812	55	2.2	26.868
1980/81	25	5.713	60	2.4	20.607
1981/82	25	6.143	68	2.72	41.007
1982/83	25	8.694	70	2.8	47.060
1983/84	50	9.587	70	1.4	30.460
1984/85	90	12.177	70	0.77	46.912
1985/86	105	9.099	100	0.96	27.941
1986/87	64	5.421	100	1.56	26.870
1987/88	N.D.	6.044	100	N.D.	36.000

N.D. : Donnée non disponible

Tableau 13. **Evolution Comparée Des Prix Au Producteur Du Mil—Sorgho Et De L'Engrais Et Des Quantítes Produites Et Utilisées**

Campagne	Prix engrais F.CFA/kg	Quantités engrais utilisées (t)	Prix du mil-sorgho F.CFA/kg	Rapport prix mil—sorgho/engr.	Quantités mil—sorgho produites (t)
1965/66	12	4.685	N.D.	N.D.	560.100
1966/67	12	9.122	N.D.	N.D.	423.500
1967/68	13	12.096	N.D.	N.D.	655.000
1968/69	12	9.645	N.D.	N.D.	449.300
1969/70	11	8.400	N.D.	N.D.	634.700
1970/71	11	6.199	17	1.5	382.211
1971/72	12	10.485	17	1.41	582.741
1972/73	12	16.435	17.5	1.46	321.865
1973/74	16	10.776	25	1.56	510.181
1974/75	16	24.909	30	1.87	800.283
1975/76	20	28.201	30	1.5	616.393
1976/77	25	30.644	35	1.4	507.185
1977/78	25	19.328	35	1.4	420.067
1978/79	25	33.133	40	1.6	802.000
1979/80	25	13.841	40	1.6	520.643
1980/81	25	26.640	40	1.6	545.072
1981/82	25	19.540	50	2	968.085
1982/83	25	8.100	50	2	585.233
1983/84	50	14.700	55	1.1	352.512
1984/85	90	11.548	60	0.66	471.447
1985/86	105	8.582	70	0.66	949.570
1986/87	64	1.090	70	1.09	633.730
1987/88	N.D.	N.D.	70	N.D.	768.800

N.D. : Donnée non disponsible

tonnes ont été effectivement distribuées. Les contraintes ayant joué sur ce faible niveau de consommation des engrais sont les suivantes :

- la vente au comptant ;
- le mauvais choix de la période de distribution ;
- l'accessibilité géographique ;
- la non-participation effective des privés pour assurer le relais de l'Etat ;
- une publicité insuffisante.

- **Bilan de la campagne 1987/1988**

L'objectif global de départ pour cette campagne en matière de distribution d'engrais a été arrêté à 52.000 tonnes dont 37.000 de NPK et 15.000 d'urée. Sur ces 52.000 tonnes, 32.000 font l'objet de la subvention de 16 FCFA/KG et le restant (20.000 tonnes) est vendu à prix courant.

Il faut signaler que cet objectif a été réajusté à la baisse par rapport à l'objectif théorique estimé auparavant à 100.000 tonnes.

Les quantités distribuées aux agriculteurs par la SRDR et la CNCAS en fonction des projets de développement figurent au tableau nf 15.

De ce tableau, on peut tirer quelques remarques :

- le taux de réalisation par rapport à l'objectif initial de 52.000 T est relativement faible : 38 % ;
- la subvention accordée aux privés (PS, commerçants, SONADIS et système coopératif), ne semble pas avoir été décisive, car les plus grand acquéreurs de cette subvention ont été les SRDR, la SONADIS, la SAED, la CSS et la SODEFITEX. Le cumul de leurs acquisitions représentent 70 % du total des ventes et les régions ayant reçu le plus d'engrais sont celles où se sont installées ces sociétés.
- le pourcentage des ventes au comptant et à crédit reste faible dans l'ensemble, sauf pour les SRDR et les projets :

- Ventes à crédit par UNCAS et SENCHIM : 1.228 T sur un objectif de 10.000 T soit 12 % ;
- ventes au comptant : 1.876 T dont OPS : 593 T sur 6000 T prévues (9,88 %) ; commerçants : 4.242 T sur 7.850 T (54 %) ;

SONADIS : 10 T sur 5000 T (0,20 %) ; sociétés : 13.166 T sur 22.110 T (56,87 %) ; projets : 652 T sur 1.040 T (62,7 %).

S'agissant de perspectives pour la campagne 1988/1989, durant laquelle la subvention sera réduite de 16 F à 8 F, l'objectif de consommation d'engrais a été ramené de 110.000 T (86.000 T d'engrais complexes et 24.000 T d'Urée) à 52.000 T (2/3 d'engrais complexes et 1/3 d'urée), car les conditions nécessaires pour réaliser ce programme n'étant pas réunies (en particulier la disponibilité du crédit).

La faisabilité d'un programme de libéralisation du commerce d'engrais rencontre des contraintes liées à la nature de

Tableau 14. **Evolution Comparée Des Prix Au Producteur De Tomate Industrielle Et De L'Engrais Et Des Quantités Produites Et Utilisées**

Campagne	Prix engrais F.CFA/kg	Quantités engrais engrais utilisées (t)	Prix du tomate tomate industrielle F.CFA/kg	Rapport prix tomate industrielle/ engrais	Quantité de tomate industrielle produites par les paysans (t)
1965					
1966					
1967					
1968					
1969					
1970	11		7	0.63	
1971	12		7	0.63	
1972	12		7	0.63	
1973	16		10	0.62	
1974	16		13	0.81	
1975	20		15	0.75	
1976	25		15	0.6	
1977	25		15	0.6	
1978	25		17	0.68	
1979	25		17	0.68	
1980	25		17	0.68	13.111
1981	25		17	0.68	17.037
1982	25		21	0.84	23.800
1983	50		21	0.46	20.035
1984	90		23	0.25	23.073
1985	105		23	0.22	8.614
1986	64		30	0.47	30.115
1987	N.D.		30	en cours	en cours

N.D. : Donnée non disponible

la marchandise et aux caractéristiques de la demande.

Cependant, ces contraintes peuvent être levées techniquement, par une nouvelle approche de fertilisation, et économiquement, par l'établissement de prix relatifs en faveur des productions agricoles, sur une période relativement longue (de 5 à 10 ans).

Cette nouvelle approche doit prendre en considération une nécessaire réadaption des types d'engrais minéraux et des modes d'épandage en matière de formulation, compte tenu des changements climatiques observés.

La conjoncture économique nationale et internationale ne favorise guère la relance de la consommation des engrais sans un soutien par une source extérieure au secteur agricole. Il apparaît donc nécessaire d'envisager la création d'un fonds de soutien pour les prix agricoles et pour la stabilisation des prix des denrées de consommation courante. Ce fonds servirait, alors, à créer des prix relatifs pour le producteur.Il pourrait être alimenté à partir des recettes des produits agricoles importés et des recettes de la vente des produits distribués par l'Aide Alimentaire Internationale, dont une partie sert actuellement de fonds pour financer des projets de développement. Ainsi ce fonds permettrait, dans le contexte de la libéralisation, l'application des prix relatifs rémunérateurs afin de garantir l'autofinancement du développement agricole. L'augmentation des revenus monétaires des ménages ruraux, entraînée par cette politique de prix, pourra donc, non seulement relancer la consommation locale d'engrais, mais aussi favoriser l'épargne nécessaire à la création d'un marché d'intrants agricoles.

A défaut de cet appui financier externe, seul le crédit coopératif subventionné pourrait relancer la consommation d'engrais en milieu rural. Cette alternative n'est pas de nature à stimuler la participation active des privés dans le commerce des engrais.

Pour les autorités gouvernementales et pour la recherche, la réduction du coût de fertilisation devient un objectif prioritaire devant l'accroissement des prix des éléments composant les fertilisants. Des perspectives se trouvent dans la valorisation agricole des ressources locales (minérales et organiques) et donc dans la poursuite des travaux menés dans ce domaine. La fertilisation minérale, n'étant qu'un élément pour la détermination des rendements, des actions pour la régénération de la fertilité des sols (amendements phosphatés, calciques et organiques) et une bonne application des techniques culturales, est indispensable à mener ou à renforcer pour l'accroissement de la production et la création de prix relatifs pour le producteur rural.

Tableau 15. **Répartition *Des Mises En Place Et Distributions D'Engrais (1987/1988)**

Sociétés		Toutes formules confondues (t)	% par rapport aux M.E.P.
SAED	D	2 277	50.03 %
	MEP	4 551	
SODAGRI	D	190.2	60.29 %
	MEP	(315.175)	
SODEFITEX	D	11 271	98.8 %
	MEP	11 870.92	
SOMIVAC	D	187.426	45.6 %
	MEP	1270.22	
PROJET ALLEMAND	D	260	100 %
	MEP	(260)	
SENCHIM	D	1 227 575	100 %
	MEP	1 227 575	
SONACOS	D	2 330	36.3 %
	MEP	(6 413)	
C.S.S.	D	2 220	100 %
	MEP	(2 200)	
SOCAS	D	60	100 %
	MEP	(60)	
TOTAUX	D	22 398.82	70.9 %
	MEP	(31 587.39)	

*Situation arrêtée à la date du 15/09/1987

( ) données incomplètes

D : distribution

MEP : Mise en place

Tableau 16. **Consommation Totale Des Engrais Par Type d'Engrais De 1976 A 1986**

Types d'Engrais	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Azotés	602,3	1.530,9	1.530,9	1.354,2	1.914	2.097,9	2.060,7	2.507,9	2.374,5	2.827,8	3.290,3
Phosphatés	38[illegible]	570,8	570,8	498,9	1.163,7	1.207,7	864,4	737,8	530,2	616,9	655,7
Potassiques	441,[illegible]	488,9	488,9	339,7	632,8	660,1	938,3	626,4	948,4	1.919,3	1.413,5
Composés	2.683,7	3.911,5	3.911,5	6.009,4	8.506,7	6.737,1	9.385,1	10.221,2	11.[illegible]1,7	17.557,9	17.154,1
Total	4.113,8	4.766,1	6.502,1	8.202,2	12.217,2	10.702,8	13.248,5	14.093,3	15.114,8	22.921,9	22.513,6

Tableau 17. **Consommation Totale Des Engrais Par Type d'Engrais De 1976 A 1986 En Pourcentage**

Types d'Engrais	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Azotés	14,7	20,3	23,5	16,5	15,7	19,6	15,6	17,8	15,7	13,3	14,6
Phosphatés	9,4	15,2	8,8	6,1	9,5	11,3	5,5	5,2	3,5	2,7	2,9
Potassiques	10,7	5,5	7,5	4,1	5,2	6,2	7,1	4,5	6,3	8,4	6,3
Composés	46,8	59	60,2	73,3	69,6	62,9	70,8	72,5	74,5	76,6	76,2

Tableau 18. **Consommation Totale En Eléments Nutritifs De 1976 A 1986 (Tonnes)**

Eléments Nutrit.	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Azote N	608,8	768,3	1.184,4	1.466,8	2.130,6	1.905,6	2.228,4	2.514,9	2.629,2	3.673,8	3.906,4
Phosphate P2O5	678,1	792,5	1.002,4	1.342,9	2.206,3	1.729,7	2.132,8	2.226,9	2.322,3	3.622,1	3.423
Potasse K20	649,7	564,5	853,8	1.095,8	1.006,2	1.331,1	1.732,8	1.718,9	1.970,8	3.300,7	2.930,7
Total	1.936,6	2.125,3	3.040,6	3.905,5	5.343,1	4.966,4	6.094	6.460,7	6.460,7	10.596,6	10.260,1

Tableau 19. **Consommation Totale Des Engrais En Pourcentage D'Eléments Nutritifs De 1976 A 1986**

Eléments Nutrit.	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Azote N	31,4	36,1	39	37,5	35,9	38,4	36,6	38,9	38	34,7	38,1
Phosphate P2O5	35	37,3	33	34,4	37,1	34,8	34,5	34,5	33,5	34,2	33,3
Potasse K20	33,6	26,6	28	28,1	27	26,8	26,6	26,6	28,5	31,1	28,6

Tableau 20. **Rapport N P K De 1976 A 1986**

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1-1,1-1,1	1-1,1-0,7	1-0,8-0,7	1-0,9-0,7	1-1-0,7	1-0,9-0,7	1-1-0,8	1-0,9-0,7	1-0,9-0,7	1-1-0,9	1-0,9-0,7

Problems Related to the Use of Fertilizers in Togo

Yao K. Atchou

Although Togo produces and exports a large amount of rock phosphate, it imports phosphate as well as other fertilizers, primarily from Europe and more recently from Senegal and Côte d'Ivoire. Since 1973, fertilizers have been heavily subsidized, and imports each year absorb large amounts of foreign exchange. But since 1983, fertilizer imports have been financed through bilateral aid. The imports are tax-exempt and are done through tenders. The collection of fertilizer consumption and stock data presents a number of difficulties, making the preparation of orders a tedious process. It takes about 6-7 months from the time an order is placed to the time a farmer actually receives the order. This is an excessive amount of time and should be reduced.

Fertilizers are packaged in 50-kg bags and transported by ship to Lomé. Losses due to rain and poor handling procedures occur during the unloading process. The transportation of fertilizers from the seaport to warehouses is handled by the SEMP (Service des Engrais et Moyens de Production). The transportation from warehouses to areas where fertilizers are to be used is carried out by different projects, government agencies, and parastatals.

While the use of fertilizers had been encouraged through subsidies, there is now a tendency to increase prices to reflect the real cost of fertilizers. Two issues arise in the context of fertilizer pricing: (a) either crop response to fertilizer use is not high enough to make the use of fertilizer profitable at existing crop prices and the real cost of fertilizers, or (b) crop prices are too low to make fertilizer use profitable. If the first situation prevails, research has to be continued in order to find ways and means of increasing crop response to fertilizer use. If the latter case is in order, some reforms in pricing policies for export crops have to be examined. Considering food crops, whose prices are determined by domestic supply and demand conditions, efforts have to be initiated to improve the efficiency of the marketing system in order to increase producer prices while reducing prices at the consumer level. On the other hand, data are being collected to help fix food crop prices at a level the government believes will stimulate production, but without any significant negative impact on food consumption.

Finally, regarding credit policy, some form of credit program could facilitate increased fertilizer purchases. Since farmers have abused credit in the past, grouping them into cooperatives with access to credit would stimulate fertilizer use.

Problèmes Relatifs A L'Utilisation Des Engrais Au Togo

Yao K. Atchou

Il est désormais établi que les engrais constituent la pierre angulaire du processus de développement agricole dans le monde. S'il fallait en effet classer les facteurs de production, les engrais viendraient directement après l'eau, considérée comme le premier élément dans la vie des hommes et des plantes.

Cette importance, ou même cette dépendance vis-à-vis des engrais, est apparue très tôt dans les pays développés où l'agriculture devait subvenir aux besoins d'une population devenue nombreuse, grâce aux progrès scientifiques et à l'industrialisation.

Dans les pays en voie de développement et spécialement en Afrique au Sud du Sahara, la nécessité de l'utilisation des engrais a commencé à s'imposer il y a environ une quinzaine d'années, non seulement pour répondre aux besoins d'une population sans cesse croissante, mais surtout pour sédentariser et intensifier une agriculture encore itinérante. L'intensification de l'agriculture permettra de mettre fin aux défrichements annuels ou bisannuels, qui accélèrent le processus de désertification menaçant l'ensemble de nos pays, car les programmes de reboisement coûtent excessivement cher et ne sauraient réparer les dommages causés.

Ce préambule, sur le contexte africain d'utilisation des engrais, nous aidera à comprendre les problèmes relatifs à la demande, à l'approvisionnement, et à l'utilisation des engrais au Togo.

Problèmes D'Approvisionnement

Sources d'Approvisionnement

Le Togo ne dispose pas de structure de fabrication d'engrais. Il est donc obligé d'importer toute la quantité d'engrais nécessaire pour son agriculture. La majorité de ces importations proviennent essentiellement des pays d'Europe. Cependant, depuis quelques années, des pays d'Afrique, comme le Sénégal et la Côte d'Ivoire, fournissent une bonne partie des engrais et des pesticides utilisés.

Le Financement de l'Importation des Engrais

Au Togo, où les engrais sont fortement subventionnés, leur importation représente d'énormes sorties de devises. Le gouvernement a institué la subvention aux engrais depuis 1973 et le Service des Engrais et Moyens de production se voit doter, chaque année, d'importants moyens financiers pour la commande.

De 1973 à 1982, cette subvention se chiffrait à environ 4 milliards 200 millions de francs CFA. Pendant cette période, tous les types d'engrais étaient cédés aux paysans à 15 FCFA le kilo.

De 1983 à nos jours, le financement de l'importation des engrais a bénéficié du fruit des relations bilatérales. Ainsi, le gouvernement de la République Fédérale d'Allemagne par le KFW et le gouvernement japonais assurent une partie des importations ; la Banque Mondiale et ses organes spécialisés, comme la Caisse Centrale de Développement Economique, assurent l'autre partie.

Le budget de l'Etat intervient chaque année pour compléter l'ensemble de ces aides extérieures précitées, notamment pour les rubriques suivantes :

- le paiement des charges portuaires et de la manutention ;
- le transport du port de Lomé aux lieux d'utilisation ;
- les autres charges.

Ces financements sous formes de dons devront permettre au pays de constituer des réserves financières en vue de faire face aux importations. Dans cette optique, ces "dons" sont vendus et leur prix de cession est fixé par l'Etat. La somme de la subvention actuelle de l'Etat est la différence entre le coût réel de revient et le prix fixé par l'Etat. Par exemple, cette année, la tonne d'urée, CAF Lomé, coûte environ 62.000 FCFA ; les frais de transport de Lomé à Dapaong s'élèvent à 14.400 FCFA (24 x 600 Km) ; les frais portuaires et de manutention sont approximativement de 7.000 FCFA, portant le prix de revient à 83.400 FCFA la tonne. Donc la subvention est de 18.400 FCFA la tonne.

L'Approvisionnement

L'approvisionnement des engrais au TOGO se fait conformément à la démarche suivante :

- Appels d'offres internationaux ou consultation dans certains cas ;
- dépouillement des plis, adjudication ;
- établissement du marché ;
- signature du marché ;
- commande proprement dite ;
- réception de la marchandise ;
- paiement au fournisseur.

1) Préparation de la Commande

La préparation de la commande est la phase qui pose le plus de problèmes au Service des Engrais. En effet, il faut centraliser les besoins des organismes, collecter les données sur la consommation pour l'année en cours (ce qui est parfois pas impossible, car sur le terrain, l'utilisation des engrais continue jusqu'à août-septembre, alors que nous voulons les chiffres aux mêmes dates), collecter les données sur les stocks (mêmes problèmes que précédemment).

Les chiffres de consommation et des stocks permettent d'analyser les besoins et de les apprécier à leur juste valeur.

2) Commande

Après avoir arrêté les chiffres sur les besoins des organismes et terminé l'établissement des cahiers de charges, la procédure décrite ci-dessus est entamée. De la préparation de la commande à la réception des marchandises au port autonome de Lomé, 6 à 7 mois s'écoulent (Cf. planning du circuit des intrants). Nous pensons que ce temps est trop long et qu'il faudra trouver un moyen pour le réduire.

3) Réception et Distribution

Les engrais sont souvent transportés en cale et conditionnés dans des sacs de 50 Kgs. Le plus souvent, les cales des navires sont étanches, mais au déchargement, les sacs subissent assez de dommages (déchirures, pertes etc..). Très souvent, à cause des retards que nous accusons, les pluies s'installent et mouillent les sacs. Même s'il s'agit de doubles sacs (sacs, tissés de polypropylène pour les sacs extérieurs et polythylène pour les sacs intérieurs), la pluie arrive toujours à les pénétrer.

Les experiences, à la réception des commandes, montrent que le transport en conteneurs est plus adéquat, mais se révèle trop coûteux.

La distribution des engrais commence dès le débarquement au port de Lomé. On distingue deux types de distribution, ou mieux deux niveaux de distribution :

- la distribution primaire : du port de Lomé vers les magasins centraux des organismes ;
- La distribution secondaire : des magasins centraux vers les utilisateurs (préfecture, sous préfecture, zones).

La distribution primaire est assurée par le SEMP tandis que la deuxième incombe aux organismes utilisateurs eux-mêmes.

Prix Des Engrais Et Des Produits Agricoles

La politique de fixation des prix et des autres moyens de production est l'une des mesures incitatives du gouvernement en faveur de l'agriculture (tableau 1).

En observant la structure des prix, on constate, en effet qu'ils ont été établis pour susciter et encourager l'utilisation des engrais. Les prix ont d'abord été fortement subventionnés, et devenant, par conséquent, intéressants pour le paysan. Après l'engouement ainsi créé, il a paru plus normal d'augmenter progressivement ces prix de façon à tendre vers les coûts réels de revient.

Actuellement au Togo, alors que nous sommes encore loin de vendre les engrais à leurs coûts réels de revient, des inquiétudes commencent à apparaître. Une étude faite par le FED dans la région des Savanes (Extrême Nord) attire toute notre attention, car si les prix des engrais augmentent davantage, les paysans de cette région ne pourront plus utiliser d'engrais, faute de rentabilité. Cette étude soulève un problème important : elle pose, d'un côté, la question de Planning du Circuit la suppression de la subvention, et de l'autre, celle de la réduction des prix des engrais à un niveau inférieur à leurs coûts réels.

Tableau 1. **Evolution Du Prix Des Engrais (en FCFA par kilogramme)**

Années	Tout type d'engrais	Engrais vivrier	Engrais coton
1973 à 1980	15	-	-
1981 à 1982	-	35	45
1983	-	40	60
1984 à 1985	-	50	100
1986 à 1988	-	65	100

Fixation des Prix des Produits Agricoles

Le problème posé au chapitre précédent (prix des engrais) appelle deux tentatives d'explications :

a) soit les facteurs de production : (eau, engrais, sol, semences) ne permettent pas des rendements pouvant rentabiliser l'engrais ;
b) soit le prix auquel les récoltes sont vendues ne permet pas de rendements financiers assez importants pouvant rentabiliser l'engrais.

Si le deuxième cas a motivé l'étude, il faut reconnaître qu'il est bien difficile de maîtriser cette situation. En effet, si on peut fixer les prix pour les produits de rente (café, cacao, coton...etc) il est difficile de les fixer pour le maïs, le sorgho, l'igname, le niébé et les autres produits alimentaires dont les prix sont régularisés par la loi de l'offre et de la demande.

Au Togo, des efforts sont entrepris afin de recueillir des éléments statistiques fiables pouvant aider le gouvernement à fixer le prix des produits vivriers. C'est dans cet optique que le journal national "La Nouvelle Marche" publie des relevés de prix de produits vivriers dans les centres et les marchés importants du pays.

Crédits

On pourrait penser que la vente à crédit des intrants de production pourrait être un atout qui favorise l'utilisation des engrais.

Au Togo, l'expérience a montré que dans le domaine des produits vivriers, vendre les engrais à crédit doit être exclu pour les raisons suivantes :

- Les paysans prennent le crédit comme un cadeau du gouvernement ;
- quand les mesures adéquates sont prises pour le rem-

boursement, le paysan évoque la mauvaise saison ou le manque de main d'oeuvre, causes de récoltes désastreuses. Dès lors, le vulgarisateur ne peut plus réclamer le remboursement à ces paysans affirmant ne rien avoir à manger.

Une des solutions envisagées actuellement est de regrouper les paysans en une coopérative et cette dernière sera responsable du prêt contracté auprès du Crédit Agricole. Là aussi, la situation n'est pas sans risque, car nous connaissons les problèmes que pose le recouvrement du Crédit Agricole dans le monde entier.

Utilisation D'Intrants Complémentaires

Il est souvent conseillé aux paysans l'utilisation d'engrais organiques (fumier, des feuilles vertes enfouies etc...) Cependant, en pratique, il se pose de nombreux problèmes : soit les paysans ne trouvent pas assez de fumier ou n'ont pas les moyens d'enfouir les herbes , soit il y a du fumier et il est fastidieux de l'épandre. L'engrais organique industriel qui constituerait la solution satisfaisante n'a pas encore fait son apparition au Togo

Il serait important de trouver des moyens de résoudre le problème des engrais organiques, afin que la stérilité de certains sols qui ne peuvent plus répondre aux seules fumures minérales soit corrigée.

Recherche Agronomique

La recherche agronomique a progressé au Togo. L'IRAT, l'IRCT, l'IRCC, la DRA etc... ont travaillé et continuent de travailler pour le développement de l'agriculture.

Cependant, dans le domaine des engrais, il existe une certaine inertie. Nous ne notons aucune évolution dans la recherche sur les engrais. L'engrais entre dans les protocoles d'essais comme tous les autres éléments (eau, sol, semence etc...) et est considéré comme un facteur déjà complètement maîtrisé. Cependant, il est encore appliqué des normes désuètes (par exemple au Togo : 250 kgs/ha).

Nous devons souligner également que même si certains organismes de recherche sont parvenus à déterminer de nouvelles doses d'application, ces résultats ne sont pas connus du Service des Engrais. Je voudrais poser, à ce niveau, le problème de circulation de l'information. Même au niveau de l'IFDC, ce sont plutôt les chercheurs qui se retrouvent au moment de faire le point sur les divers essais et nous n'avons pas l'impression d'être associés à cet effort de réflexion.

Ainsi, dans le soucis de rentabiliser l'utilisation des engrais, les autorités du département de l'agriculture au Togo, ont demandé récemment aux chercheurs de penser à l'établissement d'une carte pédologique qui indiquerait par type de sol et par région la dose adéquate à appliquer afin de pallier aux insuffisances et d'éviter les gaspillages.

Politique Incitative En Faveur De L'Utilisation Des Engrais

Elle a été suffisamment décrite dans les pages précédentes mais, il convient ici de rappeler quelques points importants :

- La subvention : l'Etat consent d'énormes sacrifices financiers pour acheter les engrais. Le prix de cession fixé pendant longtemps à 15 F/kg montre que l'Etat a supporté la totalité des coûts ;
- la création d'un service devant s'occuper spécialement des problèmes d'engrais est une preuve de l'importance, attachée à ce secteur ;
- l'exonération de la taxe douanière pour les engrais et plusieurs autres moyens de production ;
- la part du budget national, consacrée au développement rural, démontre les efforts inlassables du gouvernement pour la promotion de l'utilisation des engrais.

Historique De L'Utilisation Des Engrais Au Togo

L'introduction des engrais au Togo se situe vers les années 60 grâce à l'action des services agricoles de l'époque. C'est par l'intermédiaire de jeunes, qu'on appelait alors la jeunesse pionnière agricole (J.P.A.), que cette initiative a pu se réaliser.

Quelques années après, il y eut un projet, PNUD/TOG 72/020, sur la vulgarisation, la promotion et la commercialisation des engrais en vue de l'augmentation de la production agricole, exécuté par la FAO. Par la suite, le Service des Engrais a été créé pour s'occuper de :

- L'élaboration et de la définition de la politique en matière d'engrais ;
- la diffusion des thèmes techniques au niveau des utilisateurs;
- la commande, de la réception et de la tenue des stocks ;
- la gestion des ressources financières provenant de diverses sources : (budget national, dons, et contributions étrangères).

Annexe: Tableaux Supplémentairies

Tableau 2. **Evolution De Prix Des Engrais**

Années	Prix de revient FCFA/KG	Prix de cession aux paysans FCFA/KG[1]	Pourcentage de la subvention
1973	30	15	50
1974	61,62	15	75,6
1975	82,83	15	81,9
1976	70,54	15	78,7
1977	92,39	15	83,8
1978	62,42	15	76
1979	66,66	15	77,5
1980	89,94	15	83,3
1981	87,09	35 et 45	59,8 à 48,3
1982	90,80	35 et 45	61,5 à 50,4
1983	104,95	40 et 60	61,9 à 42,8
1984	108,73	50 et 100	54 à 8
1985	122,42	50 et 100	59,2 à 18,3
1986	131,28	65 et 100	50,5 à 23,8
1987	99,53	65 et 100	34,7 à 0

[1]De 1973 à 1980 tous les engrais ont été cédés aux paysans à 15 FCFA/Kg. A partir de 1981 on a mis une différence entre les engrais utilisés sur le coton (plus chers) et ceux destinés aux autres cultures.

Tableau 3. **Evolution De La Subvention Aux Engrais Depuis Son Institution En 1973 (en millions de FCFA)**

Années	Quantité (en tonnes)	Coût de revient des engrais	Part supportée par les utilisateurs	Coût réel de la subvention
1973	2.200	66,1	32,7	33,4
1974	2.900	178,7	43,4	135,3
1975	5.405	447,7	55,9	391,8
1976	6.450	455	110,5	344,5
1977	4.800	443,5	72	436,3
1978	8.740	545,6	131,1	414,5
1979	8.630	575,3	129,4	445,9
1980	18.480	1.662,2	277,2	1.385
1981	25.250	2.199	619	1.580
1982	15.000	1.362	635	727
1983	6.174	648	246,9	401,1
1984	15.100	1.641,9	1.105	536,9
1985	24.150	2.956,4	1,822,5	1.133,9
1986	13.764	1.807	1.160,8	642,2
1987	19.972	1.987,8	1.592,7	395,1

Tableau 4. **Evolution Des Importations D'Engrais Au Togo De 1972 A 1987**

Année	Tonnage	Valeur FCFA (1000 FCFA)	Coût moyen (FCFA/tonne)
1972	2.100	39.600	18.857
1973	2.200	56.500	25.682
1974	2.900	149.700	51.621
1975	5.405	380.800	70.453
1976	6.450	375.200	58.171
1977	4.800	384.030	80.006
1978	8.740	441.152	50.475
1979	8.630	458.642	53.145
1980	18.480	1.411.220	76.365
1981	25.250	1.923.191	76.166
1982	15.000	1.219.036	81.269
1983	6.174	596.758	96.657
1984	15.100	1.466.217	97.100
1985	24.150	2.652.575	109.837
1986	13.764	1.564.839	113.691
1987	19.972	1.736.114	86.927

Tableau 5. **Financement Des Engrais en millions FCFA (1983 - 1987)**

Année	Valeur totale des importations	Aide bilatérale	Aide multilatérale	Gouvernement togolais
1983	596,7	-	-	596,7
1984	1.466,2	801,3	-	664,9
1985	2.652,6	1.025,4	-	1.627,2
1986	1.565	605	-	960
1987	1.736	736	-	1.000

Tableau 6. **Evolution Du Prix De Cession Des Engrais Aux Cultivateurs (FCFA/KG)**

Année	Engrais vivriers et autres	Engrais coton	Actes réglementaires
1974 à 1980	15	15	Décret n° 74-6 du 15/01/74 portant application Ord. n° 14 du 12/04/73
1981	35	45	Arrêté interministériel n° 16/MDR/MEF du 27/02/81
1982	35	45	Arrêté interministériel n° 02/MDR/MEF du 19/03/82
1983	40	60	Arrêté interministériel n° 03/MDR/MEF du 25/04/83
1984	50	100	Arrêté interministériel n° 04/MDR/MEF du 03/04/84
1985	50	100	Inchangé
1986	65	100	Arrêté interministériel n° 13/MDR/MCT/MEF du 07/08/86
1987	65	100	

Tableau 7. **Consommation Totale D'Engrais Par Utilisateur En 1986 (en kilogrammes)**

Type d'Engrais	D R D R	SO to CO	Autres Organismes	Total
SA (AS)	7.150	0	35.521	105.671
UREE	709.153	1.279.122	1.196.318	3.184.593
SSP	130.575	283.622	33.650	447.847
TSP	167.425	0	39.611	207.036
PN	(PR)	0	0	900
900				
DAP	0	0	328.847	328.847
KCl	75.025	630.450	648.011	1.353.486
K2SO4	200	0	59.770	59.970
PK	0	0	0	0
15-15-15	1.407.726	1.451.411	1.183.813	4.042.950
20-10-10	0	0	2.758.762	2.758.762
12-22-12-SB	1.805.551	6.370.881	1.804.150	9.980.582
10-20-20	36.450	0	6.500	42.950
Divers	0	0	0	0
Total	4.402.255	10.015.486	8.095.853	22.513.594

Tableau 8. **Consommation Totale En Eléments Nutrififs Par Utilisateur En 1986 (en kilogrammes)**

Utilisateurs	Azote	P2O5	K2O	Total UF
D R D R	772.412	718.801	480.230	1.971.443
SO to GO	1.570.614	1.676.030	1.360.487	4.607.131
Autres Organismes	1.563.431	1.028.206	1.089.938	3.681.575
Total	3.906.457	3.423.037	2.930.655	10.260.149

Tableau 9. **Consommation D'Engrais Par Produit Et Par Culture (en kilogrammes)**

Organismes	Maïs	Riz	Sorgho	Arachide Haricot	Coton	Café Cacao	Palmiers	Fruitiers	Canne á Secre	Divers	Total
SA (AS)	37.495	26.505	14.835		1.298.851	12.588		2.250	204.000	12.000	105.671
UREE	850.824	829.824	131.723			475.029	1.100	30.042		63.200	3.184.593
SSP				442.095		1.400		4.352			447.847
TSP	50.690	18.806	15.000	116.290		1.450		1.500		3.300	207.036
DAP						328.847					328.847
PN(PR)					900						900
KCL	89.800	4.961	500	5.000	1.243.725					9.500	1.353.486
K2SO4	1.470			2.400	1.050	4.000		35.300		15.750	59.970
15-15-15	2.148.928	294.735	946.287	14.350			9.550		600.000	30.000	4.042.950
20-10-10						2.708.012				50.750	2.758.762
12-22-12SB					9.980.582						9.980.582
10-20-20	5.500			1.000						36.450	42.950
Total	3.183.807	474.831	1.108.345	581.135	12.545.108	3.531.324	10.650	73.444	804.000	220.950	22.513.584
Total (T)	3.183,81	474,83	1.108,35	581,13	12.525,11	3.531,32	10,65	73,44	804,00	220,95	22.513,59

DIVERS : pâturages, plantes ornementales, cultures maraîchères, igname, pomme de terre.

Tableau 10. **Consommation En Eléments Nutritifs Par Culture 1986 (en kilogrammes)**

Cultures	Azote	P2O5	K20	Total UF
Mais	722.007	346.622	377.919	1.446.548
Sorgho	109.495	52.861	47.187	209.543
Riz	205.651	148.843	142.243	496.737
Arachide	2.253	144.265	6.553	153.071
Coton	1.795.141	2.196.052	1.944.430	5.935.623
Café/Cacao	821.951	423.018	272.801	1.517.770
Parlmiers	1.939	1.433	1.433	4.805
Fruitiers	14.292	1.560	17.650	33.502
Canne a sucre	183.840	90.000	90.000	363.840
Diverses	49.887	18.383	30.440	98.710
Total	3.906.456	3.423.037	2.930.656	10.260.149
Total en Tonnes	3.906,4	3.423	2.930,7	10.260,1

Tableau 11. **Consommation Totale D'Engrais Par Produit, Par Region Et Par Utilisateur En 1986 (en kilogrammes)**

Regions	D R D R	SOTOCO	P D R N	S R C C	Divers	Total	% Total
Maritime	463.530	1.517.950			394.503	2.375.983	10,55
Plateaux	1.070.109	2.738.517	2.901.400	3.517.131	1.077.078	11.304.235	50,21
Centrale	855.016	1.150.378			106.850	2.112.244	9,38
Kara	1.113.700	2.200.091			13.150	3.326.941	14,78
Savanes	899.900	2.408.550			85.741	3.394.191	15,08
Total	4.402.255	10.015.486	2.901.400	3.517.131	1.677.322	22.513.594	100
%	19,55	44,49	12,89	15,62	7,45	100,00	

Tableau 12. **Consommation En Elements Nutritifs Par Region Et Par Utilisateur : Azote (T)**

Regions	D R D R	SOTOCO	P D R N	S R C C	Divers	Total	% Total
Maritime	93,6	149,7		105,1		348,4	8,92
Plateaux	222,2	449,2	351,1	817,7	239,5	2.979,7	53,24
Centrale	142,6	244,1			32,6	419,3	10,73
Kara	197,7	426,7			3,5	627,9	16,07
Savanes	116,3	300,9			13,[illegible]	431,1	11,04
Total	772,4	1.570,6	351,1	817,7	3[illegible]4,6	3.906,4	100
%	19,55	44,49	12,89	15,62	[illegible]45	100,00	

Tableau 13. **Consommation En Eléments Nutritifs Par Région Et Par Utilisateur : P2O5 (T) 1986**

Régions	D R D R	SOTOCO	P D R N	S R C C	Divers	Total	% Total
Maritime	52	244,8			34,4	331,2	10,49
Plateaux	168,3	168,3	440,8	424,6	109,1	1.311,1	41,51
Centrale	144	179,3			5,6	328,9	10,41
Kara	175,5	364,2			1,4	541,1	17,13
Savanes	179	455			12,2	646,2	20,46
Total	718,8	1.411,6	440,8	424,6	162,7	3.158,5	100
%	22,76	44,69	13,96	13,44	5,15	100,00	

Tableau 14. **Consommation En Elements Nutritifs Par Region Et Par Utilisateur : K20 (T) 1986**

Regions	D R D R	SOTOCO	P D R N	S R C C	Divers	Total	% Total
Maritime	69,1	352,3			44,1	465,5	15,88
Plateaux	100,1	412,6	622	272,8	133,6	1.541,1	52,58
Centrale	102,1	104,1			12,4	218,6	7,46
Kara	121,7	207,6			0,7	330	11,26
Savanes	87,4	283,9			4,3	375,6	12,82
Total	480,4	1.360,5	622	272,8	195,1	2.930,8	100
%	16,39	46,42	21,22	9,31	6,66	100,00	

Tableau 15. **Consommation Totale En Elements Nutritifs Par Region Et Par Utilisateur (T) 1986**

Regions	D R D R	SOTOCO	P D R N	S R C C	Divers	Total	% Total
Maritime	214,7	746,8			183,6	1.145,1	11,16
Plateaux	490,6	1.294,5	1.413,9	1.515,1	482,2	5.196,3	50,65
Centrale	388,7	527,5			50,6	966,8	9,42
Kara	494,9	998,5			5,6	1.499	14,61
Savanes	382,7	1.039,8			30 ,4	1.452,[illegible]	14,16
Total	1.971,6	4.607,1	1.413,9	1.515,1	752,4	10.260,1	100
%	19 ,22	44 ,90	13 ,78	14 ,77	7,33	100,00	

Tableau 16. Evolution de Terme de l'Echange Entre les Produits Agricoles et les Engrais

Annees	Prix aux Producteurs des Principales Cultures (FCFA/kg)				Prix de l'Engrais (FCFA/kg)		R. C. V. Rapport Valeur/Coût			
	Coton	Maïs	Sorgho	Riz Paddy	Pour Coton	Pour Vivriers	Coton	Maïs	Sorgho	Riz Paddy
1977	60	79,3	73,4	67	15	15	6,4	16,9	7,8	14,3
1978	60	35,4	45	55	15	15	7,2	7,5	4,8	11,7
1979	60	37,2	46,4	57,4	15	15	8	7,9	4,9	12,2
1980	60	68,4	68	61,6	15	15	8,8	14,6	7,2	13,4
1981	65	95,5	83,8	86,7	45	35	4	8,7	3,8	7,9
1982	65	99,8	97,3	98,5	45	35	4	9,1	4,4	9
1983	75	104	111	110	60	40	3,5	8,3	4,4	8,8
1984	90	75	89	97	100	50	2,5	4,8	2,8	6,2
1985	105	50	59	62	100	50	2,9	3,2	1,9	4
1986	105	73	76	80	100	65	2,9	3,6	1,9	3,9
1987	105	69	63	75	100	65	2,9	3,4	1,5	3,7

N.B. : Prix Moyen Annuel à la Production en FCFA/KG pour les vivriers. Prix d'Achat aux producteurs fixé par l'Etat pour le coton.

Planning Du Circuit Des Intrants

	Janvier	Fevrier	Mars	Avril	Mai	Juin	Juillet	Aout	Septembre	Octobre	Novembre	Decembre
1	Centralisation des besoins des organismes par SEMP											
2	Vérification, contrôle par SEMP ; établissement du cahier des Charges											
3	Appel d'offre—Adjudication—Commande											
4	Arrivée des intrants au Port de Lomé et Transport vers l'extérieur (régions)											
5	Distribution dans les zones											
6	(Récupération des fonds)											

La Politique Des Engrais en Zambie

Kabeta Muleya

Résumé

La consommation d'engrais en Zambie a considérablement augmenté au cours de la période 1977-1987; mais la production locale reste limitée. Le pays possède une usine d'azote qui a été mise en service en 1970. La plupart des produits fertilisants sont importés.

Les agriculteurs zambiens emploient principalement les engrais composés qui incluent (1) les composés azotés à base d'ammoniaque, (2) les composés à base de phosphore, (3) et les composés à base de potassium, et (4) le soufre en tant que sulfate en association avec d'autres charges.

La production d'azote à l'échelle industrielle a commencé en Zambie en 1981, et s'est centrée sur des mélanges NPK avec du soufre. L'usine produit également l'acide sulfurique, le sulfate d'ammonium, et l'ammoniaque. Les trois dépôts de phosphate de Chilembwe, Nkombwa, et Kaluwe combinés ont des réserves de 23 000 millions de tonnes. La prévision de la demande d'engrais en Zambie pose trois grands problèmes:

1. Un intervalle de dix-huit à vingt mois s'écoule habituellement entre le moment o commence l'opération et celui de l'utilisation de l'engrais.
2. Le manque de données fiables sur les stocks locaux.
3. L'absence de procédure d'actualisation des prévisions à l'approche des enchères.

Les principaux problèmes liés à l'achat des engrais sont les suivants:

1. Plusieurs mois sont nécessaires pour mener à terme les opérations d'achat.
2. Les devises sont limitées, et l'autorisation pour les dépenses en devises arrive tardivement.
3. Cette procédure fastidieuse compromet la régularité des importations et de la distribution.
4. Des moyens de transport ne sont pas toujours disponibles au port.
5. Le National Planning and Contingency Committee ne se réunit pas régulièrement pour planifier les achats d'engrais.

Une fois les engrais achetés, surgit le perpétuel problème de pertes. Par conséquent, les moyens de manutention et de transport doivent être améliorés. Les facteurs qui freinent la distribution des engrais sont les suivants:

1. La lente circulation des produits à l'intérieur du système coopératif.
2. Le manque de formation des agents chargés de la vente des engrais.
3. L'absence de motivation de la part des coopératives pour acheter et livrer les engrais suffisamment tôt au début de la campagne.

La politique des prix en vigueur fondée sur le système de subvention et d'uniformisation des prix a cependant favorisé une utilisation accrue des engrais.

Fertilizer Policy in Zambia

Kabeta Muleya

Introduction

Geography

Zambia occupies a tropical high plateau between eight and eighteen degrees south latitude in Central Africa. Most of the land lies at an altitude of 915 to 1,500 m.

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

Climate

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

In the Zambezi Valley, less than 250 mm of rainfall a year is not uncommon, but most of the plateau receives about 750-1,000 mm of rain. The main influences on the weather are the intertropical Convergence Zone and the Antarctic airflow across the south of the African continent.

Soils

In Zambia, six soil groups have been identified. The six broad categories of soils can be distinguished on the basis of soil suitability fertilizer-soil conversion ratios and weather as applied to rainfed maize crops.

High Potential Areas – This category includes the reddish clays found in the Kabwe-Mumbwa-Mazabuka-Chongwe-Petauke areas, and constraints are nonexistent to slight. These soils are productive on a sustained basis and are responsive to inputs such as fertilizer. Limitations may include slippery topsoils and occasional droughts.

Also included are clay soils, with sandy topsoils, occupying large areas in Southern, Eastern and Central Provinces. Use of inputs such as fertilizer is less efficient than in the above soils. In the long run, these soils need more careful management and liming practices as nutrients are leached. The main constraint is lack of adequate moisture in most seasons, but sunshine is not restrictive.

Medium Potential Areas – This area includes the acid arable soils of Northern, Luapula, North-Western, and Copperbelt Provinces occurring within the high rainfall zone. The fertility status of these loam and clay soils is very low; for a crop, such as maize, to be as productive in these areas as in the high potential areas, more fertilizer and lime are required. Sunshine may be restrictive during the growing period.

Low Potential Areas – These soils have severe to very severe constraints. Sand soils found in Western Province are rather infertile. They have a very low nutrient retention capacity and are subject to severe drought stress. Fertilizer use may be uneconomical to adapted crops, but use of organic manures is probably cheaper.

The drier and hotter valleys (Luangwa and Gwembe) have a wide variety of soil types. Constraints include lack of adequate soil moisture, alkalinity, and erosion. Frost may be another problem.

Unsuitable Areas – Floodplain soils occurring along the Zambezi, Chambeshi, and Bangwelu areas can be relatively fertile but are often very acid. In farming systems involving grassland pasture and paddy rice, nitrogen fertilizers are very important.

Land Use

Of the approximately 9 million ha of arable land, only 1.4 million ha is being cultivated.

At Independence in 1964, Zambia inherited a dualistic economy that was heavily dependent on the mining industry. There existed, on the one hand, a small but highly mechanized and efficient agricultural sector, characterized by large-scale commercial farmers, and, on the other hand, a pool of small-scale farmers who were largely neglected in terms of research and extension efforts by the centrally controlled organizations. Practically all commercial farms are situated in areas with good infrastructure facilities such as railway and class I roads.

Fertilizer Supply and Distribution, Issues, and Constraints

General Considerations

A number of factors influence the performance of agriculture in a country. It is self-evident that agricultural performance is closely connected with the quality of land. Good-quality land ensures high yield per land unit. Zambia has vast good quality land. Also, biological, chemical, technical, and sociological factors do influence the performance of agriculture. The introduction of high-yielding varieties of seed, application of fertilizers in right quantities, and proper preparation of land, among many other factors, will determine the yield to be obtained per unit of land area.

Before the 1950s, the use of all forms of inorganic fertilizers was uncommon in Zambia. Good land husbandry and conservation practices were mainly being encouraged during this period. In the 1950s, chemical (inorganic) fertilizers were introduced in the country. A number of experiments on experiment stations have confirmed that chemical fertilizers are important in increasing crop yields. As a result of this confirmation, the use of organic fertilizers has dramatically declined over the years as farmers adopted the use of imported chemical fertilizers.

Fertilizer Imports

In Zambia, fertilizer consumption has increased substantially in accordance with its increased role in agricultural production. Appendix A shows total fertilizer consumption between 1977 and 1987.

The quantity of locally produced fertilizer constitutes a small proportion of the total quantities required in the country. Thus, a sizable quantity of the fertilizer consumed is imported annually. As is the case with some food grains, Zambia also receives aid in the form of fertilizer. Important fertilizer aid donors in recent years have been the Netherlands, Norway, Japan, Italy, and Austria. Appendix B shows fertilizer imports.

Local Production

Zambia has only one fertilizer production plant, Nitrogen Chemicals of Zambia (NCZ), which is state owned and operated. The plant was built in 1969 but commissioned in 1970 to produce initially ammonium nitrate (AN), principally for the manufacture of explosives for use in the mining and civil engineering industries. Currently, ammonium sulfate (AS) is a raw material in the manufacturing of NPK compound fertilizers. Appendix C shows production levels for NCZ between the 1977 and 1987 period. The contribution of NCZ to total national fertilizer supply has increased from 15% in 1977 to 18% in 1987.

Type of Fertilizers Used in Zambia

Zambian farmers use compound fertilizer mainly. The major fertilizer compounds used are as follows:

1. Nitrogen compounds, which are ammonia based.
2. Phosphorus compounds, whose main component is phosphate.
3. Potassium compounds, whose main component is potash.
4. Sulfur, which is normally a sulfate in association with other carriers.

The percentage nutrient composition of the most important fertilizer compounds is shown in Table 1.

Table 1. **Percentage Nutrient Composition of Fertilizer Mixtures**

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

NCZ began commercial-scale production of compound fertilizers in April 1981. The NCZ plant is capable of producing all the compound fertilizers used in Zambia. It is focusing production on compounds R, X, C, and D, which represent most of the country's compound fertilizer requirements. They are also the products containing the lowest proportion of imported components. NCZ produces AN, sulfuric acid, AS, and ammonia.

Ammonia-based fertilizers are produced at NCZ using local coal from the Maamba deposit. Surveys have revealed a number of phosphate rock deposits in the country. These are located at Chilembwe, Nkombwa Hill, and Kaluwe. The estimated reserves at the three locations combined stand at 23,000 million tonnes. The deposits at Kaluwe are low grade with a P_2O_5 content of 2.5%-5.5%. The Nkombwa Hill deposit is average grade with an 8% P_2O_5 content. For Chilembwe deposit, the P_2O_5 content varies from 8% to 23% with an average value of 12%.

Fertilizer Marketing

Fertilizer procurement, in its widest sense, entails selecting the fertilizers suitable for farmers, determining the quantity of fertilizers that will be required (demand forecasting) and the source of supply (locally manufactured versus imported), and ordering fertilizers for delivery to the distribution system.

Fertilizer Selection

In Zambia product selection is largely predetermined by research recommendations carried out at the Mount Makulu Research Station. There are generally five compound fertilizers for basal application, with the most popular being compound "D" (N-P-K- of 10-20-10), "R" (20-20-0), and "X" (20-10-5). There are also two compounds that contain boron ("C" and "V") for use on tobacco. All compounds recommended for basal application contain 10% sulfur. Two straight nitrogen products, namely, urea and AN, are used for topdressing. Fertilizer products are normally packed in 50-kg (net) woven, ultraviolet-resistant polypropylene bags.

Demand Forecasting

The process of determining how much of each type of fertilizer will be required, and where, is important because these decisions will have a large bearing on whether appropriate fertilizers will be available to farmers when they need them. Demand forecasting in Zambia is hierarchical. Deciding how much fertilizer will be required begins at the local cooperative society level. At this level, the society and the local extension employees meet to determine the level of fertilizer sales and the quantity of each type of fertilizer required. The society employee does not normally have information related to production yield and marketing figures for farmers. The fertilizer figures to be arrived at are based on the estimates of the extension workers.

From the cooperative societies, fertilizer estimates are submitted to the district union for consolidation and evaluation. After consolidation and evaluation by the district agricultural and cooperative officers, all consolidated district requests are passed on to the provincial National Agricultural Marketing Board (NAMBOARD) office. The provincial extension and union officials and the NAMBOARD Manager meet and agree upon the volumes and types of fertilizers to be ordered for the province as a whole. The agreed-upon figure is then submitted to NAMBOARD Headquarters. At the Headquarters, the staff members evaluate the requests for both the types and volume of fertilizers.

In Zambia, there is a National Fertilizer Committee, which has a final say in accepting or rejecting the requested provincial quantities and types of fertilizers submitted.

It can be argued that the process of fertilizer selectio and forecasting has a number of shortcomings.

First, the length of time between the beginning of th forecasting process and when the fertilizers are used is 1 to 20 months, a very long-range forecast.

Second, the lack of solid data at the local society depo level represents a problem in putting together an accurat forecast that meets the needs of the farmers. Estimate must be made on the basis of the best guess of the depo official and the local extension personnel.

Third, there is no procedure for updating the forecas as the time for tendering fertilizer approaches. Only on forecast is made, and no attempt is made to update it a the grass-roots level once it is passed to the distric cooperative union.

Fertilizer Procurement

After the demand forecast has been completed, the process of fertilizer procurement starts. The institutions in Zambia that play a role in the procurement of fertilizers are NAMBOARD, the Bank of Zambia, the Central Supply and Tender Board, the National Contingence Committee, and a number of transporters.

Because fertilizer has to be imported, it is NAMBOARD that requests bids for the supply of the commodities by foreign companies. Once bids have been received, NAMBOARD opens and ranks them in accordance with their price and terms. The ranked bids are submitted to the Central Supply and Tender Board for approval. When bid approval is received, NAMBOARD applies to the Bank of Zambia (Foreign Exchange Management Committee [FEMAC]) for foreign exchange authorization for the tender. Normally, this process takes a long time. When authorization is granted, NAMBOARD contacts the National Contingence and Planning Committee to determine how much fertilizer has to be transported by rail and by trucks. The order is then placed with the supplier. After the supplier receives the order, NAMBOARD is informed when shipment has been made from the exporting country. NAMBOARD hires a freight forwarder to handle the fertilizer once it is at the ports.

Experience has shown that the existing fertilizer procurement process has a number of flaws, including the following constraints:

1. It requires many months for the process to be completed.
2. There is limited foreign exchange for purchase of fertilizer, and foreign exchange authorization comes late in the procurement process.

3. The numerous steps in the procurement process hinder timely importation and distribution of fertilizers.

4. Transport at the ports is not always available when needed.

5. Meetings of the National Contingency and Planning Committee are not regularly held, and thus there are delays in fertilizer procurement.

In crop production, fertilizer deliveries must conform to the biological cycle for timely fertilizer application. Any delays are costly. The delay in fertilizer procurement is attributed to the complexity of the system for procurement of fertilizer. NAMBOARD is the main actor in the procurement process, but prompt action by this organization is inhibited by the large number of clearance meetings and authorizations that must be executed before the order for fertilizers is placed.

Surely the complex inter-institutional relationships, of which the fertilizer supply and marketing system consists, have impeded and made difficult timely and accurate decisions so vital to the efficient operations of the procurement process. There is need for an organization structured solely to manage the procurement of fertilizers. To be effective and efficient, fertilizer selection and management of the delivery system must be executed and controlled in a unified manner from the source of supply to the farm gate.

Physical Distribution of Fertilizer Within Zambia

Once fertilizer is cleared at the port, the organizations that are responsible for ensuring that this commodity reaches the farmer are NAMBOARD and the various provincial cooperative unions.

Title to fertilizer is normally held by NAMBOARD until it is purchased by the cooperative unions. Cooperative unions own the fertilizer as it moves through their district and rural depots for sale to the farmers.

The ports of entry for fertilizers in Zambia are Beira, Dar-es-Salaam, and, until recently, East London, whose services are no longer used. When fertilizer is cleared, it moves by rail or road.

From Dar-es-Salaam, some of the fertilizer is directly moved to NAMBOARD regional warehouses. Some of the fertilizer is transported by rail directly to a line of rail depots owned by cooperative marketing unions in Central and Northern Provinces. Fertilizer not moved directly as above is transported to Lusaka Central Depot owned by NAMBOARD. It is from this point that the fertilizer is moved to NAMBOARD's warehouses in Copperbelt, North-Western, Western, Luapula, Eastern, and Southern Provinces. The product is purchased by cooperative unions from regional NAMBOARD warehouses. The cooperative union in each province then moves the fertilizer to district depots where it is stored in preparation for transportation to the local rural depots and/or temporary sales centers where it is sold to farmers.

Some of the fertilizer from Beira is dropped at the NAMBOARD regional depot at Chipata and along the way to Lusaka at the Eastern Province cooperative union depots at Katete, Sinda, and Petauke. From Lusaka, the fertilizer is dispatched to other parts of the country where it is stored at NAMBOARD depots for sale to cooperative unions. Most of the fertilizer dispatches to the provinces from the Lusaka main depot are based on orders made by regional depots. The orders are based on the forecasted volume requirements from the various districts.

As stated earlier, fertilizer used in Zambia is packaged in 50-kg lined plastic pocket bags. The distribution path through which the 50-kg bags pass results in a large number of handlings. Studies have shown that most pockets will be picked up, carried, and set down several times before they are opened for use by the farmer. The multiple handlings put stress on the packaging material and may cause damage before the bags reach the final user. The chances of damage are increased when it is necessary to handle every bag at each point in the physical distribution network. The fertilizer is hand-moved more than 20 times from the exporter's warehouse operations at the foreign port to the farmer's field in the country.

The number of times the fertilizer is hand-moved contributes significantly to fertilizer losses and the financial cost of those losses in the distribution network. It is estimated that there are fertilizer losses up to 20% from the original volume ordered. This shows that there is need to re-examine the present handling, storage, packaging, and transportation systems for fertilizers. Whatever fertilizer is lost represents loss of valuable and scarce foreign exchange.

In order to reduce fertilizer losses caused by several handlings while the product is in transit to the farmer, a number of measures can be instituted:

1. Delay bagging of the product until it has been moved further into the marketing system.

2. Reduce the number of fertilizer handling points so that the product can be handled fewer times than is presently the case.

3. Reduce damage by changing the handling techniques used in warehouses.

It is clear that delaying bagging will call for more equipment and trained personnel. As for shortening the distribution channel, more efforts should be made to transport fertilizer directly to regional NAMBOARD and Cooperative district depots where practicable. Current ways of storing fertilizer are likely to cause damage to fertilizers. NAMBOARD keeps large quantities of fertilizer during the months before planting. Fertilizers are stacked too high, thereby causing compression of the bags at the bottom part of the stack. Also, the principle of "first in first out" is not applied when fertilizer is marketed.

Transportation of fertilizer within the country is another constraint. Fertilizer is moved to district depots from NAMBOARD provincial warehouses. Normally, this exercise is characterized by poor timing in the delivery of the product, which causes delays to the farmer in obtaining his fertilizer. Many cooperative unions do not purchase the fertilizer in advance so that it can be transported to the rural depots at the time maize is purchased and hauled out. This is a result of inadequate funds by cooperative unions and the lack of sufficient storage facilities at the rural depots. The cost of transporting fertilizer could be significantly reduced if fertilizer could be moved to the rural depots at a time when trucks are dispatched to collect maize. There is need for effective coordination between NAMBOARD and provincial cooperatives so that fertilizer is moved to rural depots at the earliest possible opportunity.

There are a number of factors that hinder the timely dispatch of fertilizers from NAMBOARD provincial depots to the rural depots:

1. Farmers' requirements do not trigger the flow of fertilizer through the cooperative system. The fertilizer moves at the order of the provincial cooperative unions.

2. Sales personnel at the rural depots have limited knowledge in placing orders for the fertilizer.

3. Cooperatives are not given adequate incentives to buy and move fertilizer from NAMBOARD depots earlier in the season.

Presently, the procurement and wholesale activities of fertilizer are disjointed. NAMBOARD does the fertilizer procurement, whereas cooperatives do the wholesaling. The two activities are not guided by accurate information from the users of the fertilizer, the farmer. There is need for information to flow smoothly between NAMBOARD and the farmers; unfortunately, the cooperative unions do not provide the needed link between NAMBOARD and the producers.

Fertilizer Response, Pricing, and Credit

Fertilizer Response

In Zambia, four categories of farmers are recognized: traditional, improved small-scale, medium-scale, and commercial large-scale farmers. These farmers differ from one another in management practices. Management levels play an important role in determining the level of yield response to fertilizer application.

As pointed out earlier, the soils of Zambia differ in terms of fertility; soils are divided into sand, sandy loam, and sand clays. The soil type affects productivity as well as the rate of fertilizer application per unit of area.

Small-scale farmers produce more than 70% of the maize produced in the country. According to the present records, maize accounts for virtually 90% of fertilizer use. The small-scale farmers use almost all purchased fertilizer on maize, and the commercial farmers use 80%. Appendix E shows fertilizer consumption by province.

Crop response to increasing rates of application of each individual nutrient or in combination on a farmer's field form the basis of farm planning. Advisory Sheets containing fertilizer recommendations are published by the Research Branch of the Department of Agriculture. The recommendations consider three levels of soil fertility (low, medium, and high) for nitrogen, phosphate, and potash. Varieties, seeding rate, plant population, time of planting, and expected yield are considered on the sheets. The nutrient requirements for each fertility status and the fertilizer application rates are given in Table 2 and Table 3 for maize and irrigated wheat, respectively (see Table 1 for percentage nutrient composition).

Table 2. **Maize Nutrient Requirement**

Fertility Status	N	P_2O_5	K_2O	S
	(kg/ha)			
Low	160-180	70-90	30-40	20
Medium	120-140	40-60	10-20	20
High	80-100	20-30	0	21

Apply as from 200-300 "X" or "R" plus 200-300 AN kg/ha to 300-400 "D" or "R" plus 200-400 urea kg/ha.

Expected response to the fertilizer rates in Tables 2 and 3 is shown in Table 4 for different categories of farmers.

Table 3. **Irrigated Wheat Nutrient Requirement**

Fertility Status	N	P_2O_5	K_2O	S
	(kg/ha)			
Low	120-140	70-90	30-40	20
Medium	100-110	40-60	10-20	20
High	70-90	20-30	0	30

Apply as 250 "C" plus 250 urea kg/ha.

Table 4. **Expected Response of Maize and Irrigated Wheat to Recommended Fertilizer Rates**

Crop	Traditional (No Fertilizer)	Improved (Small and Medium Scale)	Commercial (Large Scale)	Top Commercial
	(kg/ha)			
Maize	900	3,600	6,000	8,000
Wheat[a]	-	2,000	4,000	6,000

a. Irrigated.

Small- and medium-scale farmers produce less maize per kilogram of fertilizer compared with commercial farmers for the fertilizer rates shown in Table 2. This is explained in part by the following factors:

1. Small-scale farmers depend on oxen or hand cultivation, which requires the onset of rains before cultivation. Also, oxen are generally out of condition after winter grazing and need the first flush of grass to regain strength for plowing.

2. As a result of the late land preparation, the maize crop is planted late, which leads to lower yields.

3. Small-scale farmers do not use herbicides, and they suffer labor constraints during the optimum period for weeding.

4. Inputs such as fertilizer and seed arrive late, and this seriously affects production efficiency.

A number of measures have been taken to improve fertilizer use efficiency in the following areas:

1. To encourage winter plowing where oxen are used. This allows early planting and helps to conserve soil moisture for early germination.

2. To plant appropriate varieties for specific location and planting period.

3. To ensure timeliness of inputs such as seed and fertilizers.

4. To improve provincial and district recommendations, using soil analysis as a guide.

5. To encourage more intensive production, which reduces labor constraints for weeding.

No amount of good fertilization will increase crop yields if soil preparation is neglected. While some crops could still survive under rough, cloddy conditions, the majority will require a properly prepared seedbed to give good germination.

During the last few years, plant breeders have come up with improved varieties of crops able to realize higher yields than the open-pollinated ones. The hybrid varieties are able to use fertilizers more efficiently than the open-pollinated ones. Crops that are not adapted to an area may not respond profitably to fertilization. Fertilization should be timed with the growth periods requiring nutrients. It is no use applying more fertilizer when the crop does not require it for its growth. Timely distribution of fertilizer is paramount to ensuring maximum efficiency in use.

Most farmers in Zambia plant their maize with the first rains. Delayed planting reduces crop yield. Delayed planting may lead to inefficient use of fertilizer, especially N which interacts with water available during the growing season to give maximum yield. Additional fertilizer may not lead to increased yields when water is a limiting factor.

Recommended fertilizer levels assume that enough nutrients are being supplied to each plant for proper growth, which avoids competition. Too few or too many plants per hectare often limit returns from added fertilizers on row crops. Conditions of lower soil fertility should therefore carry lower plant populations than recommended, and vice versa for high fertilizer levels, in order to maximize yields at each fertilizer level.

Returns from proper fertilization and other inputs may be minimal if diseases and pests prevail on the crop. It is, therefore, essential to have a sound disease and pest control system in place. Also, unweeded fields have been shown to give little or virtually no returns even when fertilized because of competition prevailing between crops and weeds for the limited nutrients.

None of these practices alone will maximize the benefits derived from fertilizer use. A package approach is

essential to maximize yields. In considering yield levels, it is important to take into account the role of light in plant growth. Lack of light during the vegetation period affects yields. Heavy cloud cover for weeks during the rainy season prevents high levels of assimilation. In Zambia, small-scale farmers hardly apply herbicides and pesticides; this affects productivity per unit of area.

Fertilizer Pricing Policy

In Zambia, the objectives of fertilizer pricing policy have been to increase fertilizer use by all farmers, especially small-scale producers, in order to stimulate increased food production. To achieve these objectives, two instruments have generally been used:

1. Subsidies.
2. Pan-territorial pricing systems.

The price subsidies take two forms. There is a price differential subsidy to reimburse NAMBOARD and its agents for retailing fertilizer at a price lower than the average of the imported and locally produced product. Also, there is a handling and transportation subsidy paid because of the policy of uniform pricing. (See Appendix D.) Thus, the farmers purchase fertilizer at a price which reflects neither the total cost of production and procurement nor the total cost of transportation and handling. Under a pan-territorial pricing system, the price of fertilizer is uniform throughout the country.

Fertilizer subsidization and the pan-territorial pricing system have helped the Government achieve the objective of increasing fertilizer use. However, the current pricing system is characterized by a number of constraints. The first constraint is the negative impact the uniform pricing has in providing an incentive to move the fertilizer efficiently and effectively through the distribution system. Prices should be structured in a manner that provides incentives to marketing and supply organizations to move fertilizer efficiently through the system in a timely way.

Under the present arrangements, unions minimize costs by delaying purchase and movement of fertilizer until the latest possible time. This approach reduces inventory, maintenance of storage facilities, and acceptance of financial responsibility for the products. The restitution payment by the Government will be the same, no matter when the cooperative unions move the fertilizer. There should be a price differential taking into account the storage cost so that fertilizer would cost more for late purchases and less for early ones. This would definitely encourage the movement of fertilizer in a timely fashion, and the early arrival of fertilizers at the farm gate would be very rewarding in terms of increased yields. The present arrangement forces the movement of fertilizer at a non-optimal time.

The second constraint of artificially depressing fertilizer price throughout the country has resulted in a tendency to encourage the liberal use of fertilizers throughout the country. This approach is good where agronomic conditions are similar. This is not the case in Zambia, which means that a high degree of fertilizer efficiency is not obtained at the national level.

The subsidies have put a substantial financial burden on the Government budget. Therefore, they have been gradually reduced with measures introduced by the Government.

Fertilizer Credit

In Zambia, credit to farmers is provided by both private and public institutions. Two private sector banks, Barclays and Standard, are active in the field of agricultural credit, and their business is with both commercial and small-scale farmers. Part of this credit is given for fertilizer purchases. Production credit is given for fertilizer purchases. Production credit is given on a 12-month term with interest up to 20%/year. There is a state commercial bank, the Zambia National Commercial Bank, which extends credit to farmers of all categories.

After the dissolution of the Agricultural Finance Company (AFC), the Lima Bank was established in 1986/87. This is a parastatal agency whose responsibility is to extend credit to farmers. Annual disbursement stands at K150 million. It is too early to evaluate the performance of this bank.

There are also credit cooperative organizations in existence in Zambia. In 1979/80 they extended credit of K65,688,000 to agriculture. In 1983/84, credit to agriculture increased to K154,870,000.

Organic Fertilizers and Lime

Over the past years, dramatic increases have taken place in fertilizer consumption. In order to bring about this increase, subsidies had to be paid to make fertilizer affordable by as many farmers as possible, particularly the small-scale ones. In general, areas of production are remote in Zambia, and thus costs of transporting fertilizers and farm products are a major constraint. Therefore, other alternatives to inorganic fertilizers need to be considered.

Green Manures

The practice of green manure has virtually disappeared from all farming systems as being uneconomic in spite of the fact that farmers appreciate the benefits.

For most farmers, to prepare land and purchase seed only to plow under in March/April for the following

November/December planting is unattractive. It is argued in some cycles that average crop production would be lower because no crops would be produced in the season of green manure. Unless the number of farmers has increased, or a larger area is cultivated, there would be a shortfall in production.

Green manures form part of a low-input biological approach to farm productivity. However, such low-input biological systems can be as economically viable as high-input systems because capital investments are much reduced. They are generally lower in productivity than the high-input systems but still significantly higher than traditional systems, and they can be more permanent.

Crop Rotations

Rotations involving cash crop legumes are an economic alternative to green manuring. Groundnuts are a case in point, as are soybeans. Soybeans are grown by both small-scale and large-scale farmers in Zambia.

Intercropping

This practice is being encouraged because trials have shown an increase in productivity per unit area and a greater degree of insurance to farmers against drought, pests, and diseases. Examples of intercropping are maize with beans and cowpeas with sorghum, etc.

Animal Manure

The beneficial effects of using animal manures have been well demonstrated in Zambia. This is also accepted by the farmers. Where animals graze crop residues, the manure is automatically returned to the fields, thus enhancing soil fertility. In Zambia, large animal herds are found only in Southern, Central, and Western Provinces. However, farmers are neglecting deposits of kraal manure mostly in favor of inorganic fertilizers. The aim should be to reduce overdependence on agrochemical farming because a high-input, fertilizer-based technology involves expensive imports of fertilizer products.

Agricultural Lime

Surveys have identified local deposits of limestone in most parts of the country. These deposits have not been exploited, and consequently there is virtually no lime available in rural areas for small-scale farmers. Also, a large and unsatisfied demand exists in the commercial agricultural sector. Large areas of Zambia have naturally acidic soils in the virgin state, and even those more fertile soils become acidic with more intensive crop production.

The rainfall does affect the degree of development of Zambian soils. In the northern and north-western regions of Zambia where the rainfall approaches 50 inches per year, the soils are strongly leached, have a low base saturation, are strongly acid, and have a clay fraction consisting of kaolinite.

As with fertilizer, the Department of Agriculture has established recommendation rates for lime applications for each soil texture per crop. For maize and irrigated wheat lime applications are recommended as shown in Table 5.

Table 5. **Recommendations for Application of Lime to Maize and Irrigated Wheat**

Soil Texture	Critical pH	Maintenance Lime Requirements (kg/ha)
Maize		
Sands	4.4	500-1,000
Sandy loams	4.6	1,000-1,500
Sandy clays	4.8	1,500-2,000
Irrigated Wheat		
Sands	4.6	500-1,000
Sandy loams	4.8	1,000-1,500
Sandy clays	5.0	1,500-2,000

The chemical composition of soils reveals a wide variation in the need for application of agricultural lime. By renewing or improving the soils of Zambia, the application of lime is a measure to conserve natural resources. Soil acidity caused by fertilizer application restricts crop yields. The availability of lime at the farmer level is a most pressing fertilizer problem.

Agricultural Extension and Research

Zambia maintains a number of stations from which extension workers operate. There is one extension worker for each 500-600 farm units. There are also a number of research stations at both regional and district levels. Apart from extension workers under the Department of Agriculture, there are some who operate under the direct control of specialized organizations such as the National Tobacco Company of Zambia and the Lint Company of Zambia.

It is recognized that fertilizer use increases crop production. To ensure efficient nutrient use, fertilizer use recommendations should be required to comply with local soil and crop conditions. Through research, crop response curves can be obtained for the many soil conditions and all levels of farm management now recognized in Zambia.

Research personnel are organized in segments/teams. In particular, there are Specialist Research Teams. There is the soil Chemistry, Physics, and Microbiology Team and the Soil Productivity Research Program. The research program in soil chemistry has examined the micronutrient status of some Zambian soils and the associated micronutrient deficiencies in crops. Overall, these research studies are somehow remote from the current realities of smallholder farming as they assume that there are not more pressing issues that require attention, e.g., soil conservation.

In Zambia, the current level of training of extension workers and those operating within the fertilizer marketing system leaves much to be desired. To remedy this situation, the "National Lima Fertilizer Program" has been instituted. The program is designed to improve extension's delivery of information about fertilizer to small-scale farmers. It also provides a database of fertilizer use by small-scale farmers.

So far, fertilizer marketing organizations do not play a role in any fertilizer educational efforts with farmers. Fertilizer marketing organizations should sponsor demonstrations, field days, and farmer meetings. A substantial amount of fertilizer is being wasted. There is need for improved marketing management skills. There should be on-the-job training for all extension workers and fertilizer marketing organizations on fertilizer inventory management, warehousing, and handling. It is hoped that these measures will lead to the provision of fertilizers in required quantities and in a timely fashion to the farmers.

Appendix A. **Fertilizer Consumption by Type for the Last 10 Years**[a]

Commodity	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	(tonnes)									
Compound										
A	480	150	58	4	18	6	6	-	34	.
C (6-18-12)	6,000	4,300	5,400	6,900	4,200	2,300	2,500	5,000	3,300	6,800
V (4-18-15)	3,600	1,300	1,600	2,300	1,400	750	1,300	1,200	680	2,000
R (20-20-0)	17,000	26,500	39,000	42,000	32,000	17,000	19,000	22,000	13,500	22,000
X (20-10-5)	20,000	20,000	36,000	30,000	38,000	29,000	34,000	27,000	38,000	49,000
D (10-20--11)	30,000	28,000	29,000	36,000	33,000	43,000	22,000	58,000	42,000	64,000
12-24-12	-	-	-	-	-	-	723	214	47	-
Nitrogenous										
AN	20,000	18,000	24,000	26,000	21,000	16,000	12,000	9,000	7,000	18,000
SA	2,000	900	1,000	2,000	2,000	300	100	1,000	60	1
Urea	28,000	42,000	57,000	65,000	59,000	53,000	44,000	76,000	79,000	72,000
N/S	600	150	170	300	30	21	17	69	33	50
CAN	-	-	-	-	-	-	2,000	5,000	1,000	7,000
Phosphate										
SSP	300	140	500	300	100	150	130	150	400	150
TSP	1,600	1,600	2,000	2,000	600	700	300	800	1,500	600
Potash										
P/S	60	60	80	200	60	60	200	80	7	7
P/C	90	150	150	200	40	100	50	60	2	14
Mixed TSP and SSP	-	-	-	12	90	600	8	150	-	-
Lime mixture	-	-	-	-	-	-	440	125	9	100
Gypsum and other	470	2,000	200	7,000	7,000	2,000	6,000	6,000	3,000	3,500
Totals	130,200	145,250	196,158	220,216	198,538	164,987	144,768	211,848	189,572	245,222

a. Figures are rounded.

Source: National Agricultural Marketing Board Reports, 1988.

Appendix B. **Fertilizer Imports From 1977 to 1987**[a]

1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	
	('000 tonnes)										
Imports-Commercial											
P/S	-	2.8	-	-	-	-	-	-	-	-	.8
C (6-18-12)	10	3	-	5	6	7	3	-	-	-	6
V (4-18-15)	3	-	-	-	-	2	3	-	-	-	.2
R (20-20-0)	29	11.5	-	-	30	30	-	-	-	12	-
X (20-10-5)	-	-	-	-	29	30	-	-	-	-	13
D (10-20-10)	11	-	-	21	45	60	40	74	-	24	32
Urea	-	-	-	54	35	60	75	54	-	15	31
A/N	-	-	-	-	-	-	-	-	-	5	28
N/S	1	.7	-	-	-	-	1	-	-	-	-
SSP	-	-	-	-	-	1	1	-	-	-	-
S/R	6	-	-	-	-	-	-	-	-	-	
TSP	6	-	-	-	-	-	-	-	-	-	1
Subtotal	66	18	-	80	145	190	123	128	-	56	112
Imports-Aid											
FMP	-	-	-	-	-	-	-	-	-	-	1
S/A	-	8	-	-	-	-	-	-	-	-	-
X	30	21	20	35	16	-	-	-	-	24	15
R	-	11	36	43	-	20	-	-	-	-	-
Urea	50	73	40	13	-	10	11	42	30	49	58
CAN	-	-	-	-	-	-	-	25	-	-	-
B/C	4	60	1	-	-	-	-	2	-	10	29
C/C	-	-	-	-	-	-	-	-	-	4	3
V/C	-	-	-	-	-	-	-	-	-	2	10
TSP	-	2	-	-	-	-	-	-	-	-	-
Subtotal	84	175	97	91	16	30	11	69	30	89	116
Total	150	193	97	171	161	220	134	197	30	145	228

a. Figures are rounded.

Appendix C. **Fertilizer Production at Nitrogen Chemical of Zambia (1977-87)**[a]

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	('000 tonnes)										
A/N	27	26	26	19	14	26	18	9	7	7	12
X (20-10-5)	-	-	-	-	2	-	18	50	4	22	-
R (20-20-0)	-	-	-	-	4	12	10	19	10	6	32
C (6-18-12)	-	-	-	-	-	-	3	-	-	-	-
TSP	-	-	-	-	-	-	3	1	-	-	-
D	-	-	-	-	-	-	-	-	-	21	3
Total	27	26	26	19	20	38	52	79	21	56	47

a. Figures are rounded.

Source: National Agricultural Marketing Board Report, 1988.

Appendix D. **Subsidies on Fertilizer in Millions of $Z, 1980-84**[a]

	1980	1981	1982	1983	1984
Price differential	36	28	32	12	12
Handling	16	10	19	8	8
Total	52	38	51	20	20

a. Figures are rounded.

Appendix E. **Fertilizer Sales by Province (1981-86)**[a]

	1981	1982	1983	1984	1985	1986
	('000 tonnes)					
Zambia						
Total sales	212	213	163	134	200	390
Central						
Total sales	56	52	36	35	50	94
% of national	26	24	22	26	25	24
Copperbelt						
Total sales	5	8	5	8	11	11
% of national	2	4	3	6	6	3
Eastern						
Total sales	28	34	40	18	55	50
% of national	13	16	25	13	28	13
Luapula						
Total sales	.6	1	2	2	4	19
% of national	.3	.5	1	1	2	5
Lusaka						
Total sales	26	34	18	12	16	34
% of national	12	16	11	9	8	9
Northern						
Total sales	15	21	19	18	12	48
% of national	7	10	12	13	6	12
Northwestern						
Total sales	2	2	2	1	2	2
% of national	.9	.9	1	.7	1	.5
Southern						
Total sales	78	59	37	39	46	83
% of national	37	28	23	29	23	21
Western						
Total sales	2	1	2	3	4	43
% of national	.9	.5	1	2	2	11

a. Figures are rounded.

L'Utilisation Des Engrais au Zimbabwe: Problèmes Liés à l'Achat, la Demande, et la Politique Des Engrais

Emmanuel Sakala

Résumé

L'agriculture joue un rôle crucial dans l'économie du Zimbabwe. Elle contribue pour près de 15 pour cent au Produit Intérieur Brut, 54 pour cent de la création totale d'emplois, 26 pour cent des emplois dans le secteur structuré, et 41 pour cent du total des exportations. Le secteur agricole compte 4 500 grands planteurs occupant 13,5 millions d'ha, 4 millions de petits exploitants disposant de 16 millions d'ha, et 8 500 petits agriculteurs à vocation commerciale qui cultivent 1,5 million d'ha. Quarante-deux pour cent des terres agricoles sont des biens communautaires; 4 pour cent sont cultivées pour le petit commerce, et 40 pour cent sont exploitées pour la production à grande échelle.

L'emploi des engrais chimiques a commencé au Zimbabwe dans les années vingt. Vers 1926, par exemple, une usine installée à Harare produisait déjà une vaste gamme d'engrais composés NPK qui couvraient les besoins de tout le pays. Toutes les matières premières étaient cependant importées. Une deuxième usine a été mise en service en 1933, et une troisième en 1960.

La politique agricole du Zimbabwe est basée sur la volonté du gouvernement de parvenir à "la croissance avec équité". Cette politique découle de la nécessité de réduire les inégalités entre la production industrielle et la production paysanne traditionnelle.

Une partie des engrais phosphatés et azotés est produite sur place; le reste est importé. Les engrais azotés sont fabriqués localement à partir d'ammoniac-anhydre sous forme d'urée. Deux cent vingt mille tonnes de nitrate d'ammonium (AN) sont produites annuellement par Sable Chemical Industries. Zimbabwe Phosphate industries produit annuellement quarante trois mille tonnes de P_2O_5. Tout le potassium utilisé est importé.

La commercialisation et la distribution des engrais sont laissées à la charge de la Zimbabwe fertilizer Company and Windmill Limited. La livraison est assurée par l'intermédiaire des groupements d'achat (sociétés primaires) et des coopératives. Le Zimbabwe compte trois cents coopératives primaires, quatorze unions de coopératives, et cinq cents sociétés primaires.

Les prix des engrais sont fixés par le gouvernement. Bien que la subvention directe ait été supprimée en 1975, des engrais importés à bon marché, tels que l'urée, sont souvent vendus à des prix plus élevés en vue de subventionner les produits locaux qui sont plus chers, tels que le nitrate d'ammonium.

Les prix des engrais sont établis sur la base des considérations suivantes: (1) les prévisions concernant les prix de vente des engrais et des produits agricoles, (2) le cot des matières premières et de la production, (3) les frais généraux et les marges bénéficiaires, (4) les marges de commercialisation, et (5) les cots de production au niveau de l'agriculteur. Le problème majeur qui caracterise ce système est l'annonce tardive du prix des engrais.

Les principales contraintes liées à la commercialisation des engrais sont l'éloignement des zones de culture, et l'insuffisance de moyens de transport et de stockage. Les distributeurs ne disposent pas de point de vente en milieu rural; c'est l'acheteur qui assure la circulation des engrais. Les réseaux routiers et ferroviaires desservent adéquatement les fermes commerciales, mais le transport vers le secteur des petits paysans est plutôt négligé.

La demande d'engrais est largement influencée par les prix de vente des produits agricoles. L'emploi de cet intrant est plus rentable sur le soja, le blé et le coton.

L'augmentation du taux d'utilisation des engrais qui a été observée entre 1980 et 1984, s'explique principalement par une extension importante des crédits qui sont passés de Z 1 million à Z 16 millions au cours de cette période.

Il est nécessaire que le Zimbabwe adopte l'approche de la prévision à moyen et à long terme, au lieu de la prévision annuelle. Une période de cinq ans semble raisonnable pour une politique efficace qui s'attacherait à développer des services de recherche, de vulgarisation et de crédit pour les agriculteurs.

Fertilizer Use in Zimbabwe: Supply, Demand, Policy, and Related Problems

Emmanuel Sakala

Introduction

Zimbabwe is a landlocked country with a surface area of 39.07 million ha. It is situated in Southern Africa between 25° and 33° east longitude and 15° and 22° south latitude. Since independence in 1980, the Government of Zimbabwe has given priority to agricultural and rural development. This emphasis is not misplaced in that over 70% of the country's population of about 8 million lives in rural areas and derives its livelihood largely from agriculture. However, in common with most other developing countries, Zimbabwe is faced with the twin problem of insufficient foreign exchange and a growing demand for imported agricultural inputs, including fertilizer. The objective of this paper is to discuss fertilizer use in Zimbabwe, in particular, fertilizer supply, demand, policy, and related problems.

Agriculture in Zimbabwe

Agriculture plays a crucial role in the overall economy of Zimbabwe. It accounts for approximately 15% of gross domestic product, provides 54% of total employment in the rural sector, provides 26% of formal sector employment, and accounts for approximately 41% of total exports. The agricultural sector in Zimbabwe is essentially dualistic, comprising (1) a modern technologically advanced sector with about 4,500 large-scale commercial farmers occupying some 13.5 million ha of land under freehold title, plus farm laborers and their families totaling about 1.2 million people and (2) a traditional smallholder sector comprising some 800,000 farm families totaling about 4 million people occupying 16 million ha of land in the communal areas. Land tenure in this subsector is based on traditional rights previously allocated by the hereditary chiefs but now controlled by the District Councils. There are also some 8,500 small-scale commercial farmers on about 1.5 million ha under tenancy or freehold title, and about 40,000 families who have now been settled on approximately 2 million ha of land.

Land in Zimbabwe is demarcated on the basis of five Agro-Ecological Regions (Natural Regions). Regions I, II, and III have greater agricultural potential than Regions IV and V. Table 1 shows the distribution of land within the commercial and communal areas by Natural Regions. As the table shows, 52% of commercial sector land is in Natural Regions I, II, and III, and 74% of communal land area is in Natural Regions IV and V. Hence, although the two sectors have about the same amount of land, the quality of that land is such that the commercial sector is endowed with a better natural resource base.

Table 1. **Land Classification by Natural Region**

	Land Used for Agriculture			Other Land		
	Communal Land	Small-Scale Commercial	Large-Scale Commercial	Forest	National Parks	Total
	(million ha)					
Nat. Reg. I	0.14	0.01	0.43	0.07	0.05	0.70
Nat. Reg. II	1.27	0.25	4.33	-0	0.01	5.86
Nat. Reg. III	2.82	0.54	3.24	0.14	0.55	7.29
Nat. Reg. IV	7.34	0.52	4.03	0.64	2.25	14.78
Nat. Reg. V	2.78	0.10	3.65	0.07	1.84	10.44
Total	16.35	1.42	15.68	0.92	4.70	39.07
Percentage	42	4	40	2	12	100

Note: The resettlement of farmers on former large-scale commercial land has since resulted in a slight decline in the land used by large-scale farmers for agricultural purposes.

Agricultural Policy

Agricultural policy in Zimbabwe is based on the Government's desire to achieve "growth with equity." This policy is inspired by the need to remove the disparities between large-scale commercial production and traditional peasant production and between rural and urban communities.

The main objectives of agricultural policy in Zimbabwe are, broadly speaking, to facilitate the achievement of self-sufficiency in the availability of food and agricultural raw materials on a sustainable basis and to maximize the contribution of agriculture to foreign exchange earnings, employment creation, industrial growth, and rural development.

Fertilizer Use – Historical Background

The use of inorganic fertilizers in Zimbabwe began in the 1920s. By 1926, for instance, a factory in Harare was already producing a comprehensive range of compound fertilizers (i.e., N, P, and K) sufficient for the whole

country. All raw materials were, however, imported. A second factory was blending and packing fertilizer by 1933. In 1950 a third factory was commissioned. By 1960 the analysis of soils in Zimbabwe showed that available nutrients had reached a very high standard because of optimum levels of application of inorganic nutrients for maximum yields and quality. These levels have changed marginally since then.

Fertilizer Procurement and Supply and Related Policies

Fertilizer materials and products are both locally produced and imported. Two of the three main fertilizer nutrients, i.e., nitrogen and phosphate, are manufactured locally, but existing capacities are insufficient to meet the country's full needs. Nitrogenous fertilizer needs are met from local production based on imported anhydrous ammonia. The shortfall in nitrogen is imported in the form of urea.

Sable Chemical Industries, situated in the Midlands, manufactures ammonium nitrate (AN). AN is produced from nitric acid, manufactured onsite, and ammonia; two-thirds of the ammonia is produced onsite by the process of electrolysis, and the other one-third is imported. The plant is capable of producing about 220,000 tonnes of AN annually using both locally produced and imported ammonia.

Zimbabwe Phosphate Industries (Zimphos), based in Harare, manufactures single and double superphosphate, and an associate company is responsible for the mining of rock phosphate. Dorowa Phosphate began open-cast mining in the southeast of the country and is now producing approximately 140,000 tonnes of raw rock annually. The rock is transported to Zimphos factory in Harare. The plant has a capacity to produce about 43,000 tonnes of P_2O_5 per year. The sulfuric and phosphate acids used in the manufacture of phosphate fertilizers are also produced by Zimphos at the Harare factory. All potassium has to be imported into the country as there are no local sources. Table 2 shows importation of fertilizer and fertilizer products in 1981 and those anticipated in 1988.

Table 2. **Fertilizer Imports**

	1981		1988 (Estimate)	
	Tonnes of Product	Tonnes of Nutrient[a]	Tonnes of Product	Tonnes of Nutrient[a]
Nitrate of potash	33,700	16,783	37,800	18,824
Sulphate of potash	15,433	6,405	20,050	8,321
Urea	93,500	43,010	14,000	6,440
Ammonium sulfate	12,000	2,520	12,000	562
Nitrate of soda	2,000	320	2,700	432
Anhydrous ammonia	31,127	36,000		

a. N and/or K_2O.

Fertilizer Marketing

In Zimbabwe, the Government is not involved in the marketing and distribution of fertilizers; this is left to two private firms, Zimbabwe Fertilizer Company and Windmill (Private) Ltd. These two companies supply virtually all requirements for the commercial farming sector, and to a lesser extent they supply the communal (peasant) sector. The companies also supply the urban or "garden" market.

Delivery of fertilizer to communal area farmers is largely through group purchases and cooperatives. This is convenient because communal farmers comprise 800,000 farm families who are very widely dispersed.

The cooperatives play an important role in fertilizer marketing in the peasant sector. The cooperative movement was established by the Cooperatives Societies Act of 1956 and was designed to provide for the organization of self-help groups which fall into two categories:

1. Formally constituted cooperative movements.
2. Informal savings and development clubs.

By 1981 some 330 primary cooperatives, with a membership of 41,000, were functional and engaged in agricultural marketing and input supply. To date, there are over 500 primary societies with over 70,000 members. They are organized into 14 cooperative unions which, in turn, provide wholesaling of inputs, produce marketing, and accounting services.

Along with primary cooperative societies, a number of small savings clubs have been developed. There are over 1,200 clubs now providing inexpensive and simple saving and credit opportunities for members to purchase agricultural inputs. Figure 1 shows the fertilizer distribution channels in Zimbabwe, and Table 3 shows fertilizer sales by product type in 1986/87.

Fertilizer Pricing Policy

The price of fertilizer is decided by the Government after an annual review and discussions with manufacturers and other relevant bodies. Fertilizer subsidies were removed in 1975, and there are therefore no direct subsidies reflected in the prices of the individual fertilizer products. However, there is an equalization fund under which the cheaper raw materials "subsidize" the more expensive ones. For example, urea is sold at exactly the same price per nutrient tonne as ammonium nitrate, but it is imported at a considerably lower price per unit of nitrogen than the cost of ammonium nitrate, which is locally produced.

The pricing of all fertilizer products is determined following negotiations between the industry and

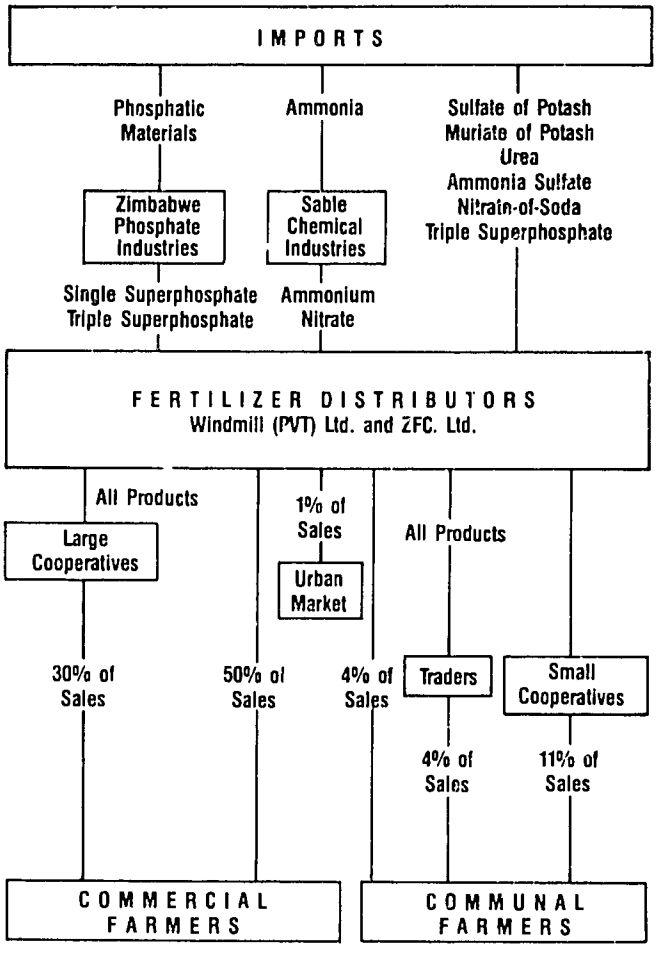


Figure 1. **Fertilizer Distribution Channels in Zimbabwe.**

Government. Each submission by the industry provides detailed costs of the various elements involved in the proposed price, including an applicant's last audited profit-and-loss account, to the Ministry of Trade and Commerce for scrutiny. A paper in support of the price recommendations is prepared and submitted to the Ministerial Economic Coordinating Committee (MECC), which consists of officials from the Ministry of Trade and Commerce, Agriculture, Industry and Technology and Finance. MECC makes the final recommendation to Cabinet. The pricing procedure takes into account the following factors among others:

1. Forecasts of fertilizer sales and agricultural crop prices.

2. Cost of raw materials and production.

3. Companies' overhead costs and a certain profit margin to allow for an adequate return on investment.

4. Trading margin.

Table 3. **Fertilizer Sales by Product Type, 1986/87**

Fertilizer Compound		Sales in Product Tonnes	Sales in Tonnes of Nutrient
Compound A	(2.17.15)	3,804	1,293
Compound B	(4.17.15)	9,183	3,305
Compound C	(6.17.15)	40,030	15,091
Compound V	(4.17.15)	8,310	2,992
Compound D	(8.14.17)	95,980	27,901
Compound J	(15.5.20)	10,350	4,140
Compound L	(5.18.10)	37,394	12,818
Compound M	(10.10.10)	13,337	4,001
Compound P	(10.18.0)	2,851	798
Compound S	(6.17.6)	13,662	3,962
Compound X	(20.10.5)	2,826	989
Compound T	(25.5.5)	5,804	2,031
Compound Z	(18.4.7)	15,458	4,483
Total Compounds		**258,989**	**83,804**
Ammonium nitrate	(34.5%)	141,919	48,948
Nitrate of soda	(16% N)	2,199	352
Sulfate of ammonia	(21% N)	749	157
Urea	(46 N)	27,155	12,491
Single supers	(18.5% P_2O_5)	10,913	2,019
Double supers	(37% P_2O_5)	6,165	2,281
Nitrate of potash	(60% K_2O)	6,632	3,979
Sulfate of potash	(50% K_2O)	1,522	761
Total		**456,243**	**154,792**

Source: FAO paper on Fertilizer Marketing in Zimbabwe. Ministry of Lands, Agriculture and Rural Resettlement.

5. Farmers' cost of production taking into consideration the costs of other inputs.

A major criticism of the system has been the delay in announcing fertilizer prices. The recognized fertilizer year is from March 1 to February 28. However, fertilizer price increases have sometimes been delayed by Government until July, thereby compelling trading companies to sell fertilizers in March, April, May, and June at prices based on the old price structure.

Marketing Policy and Related Problems

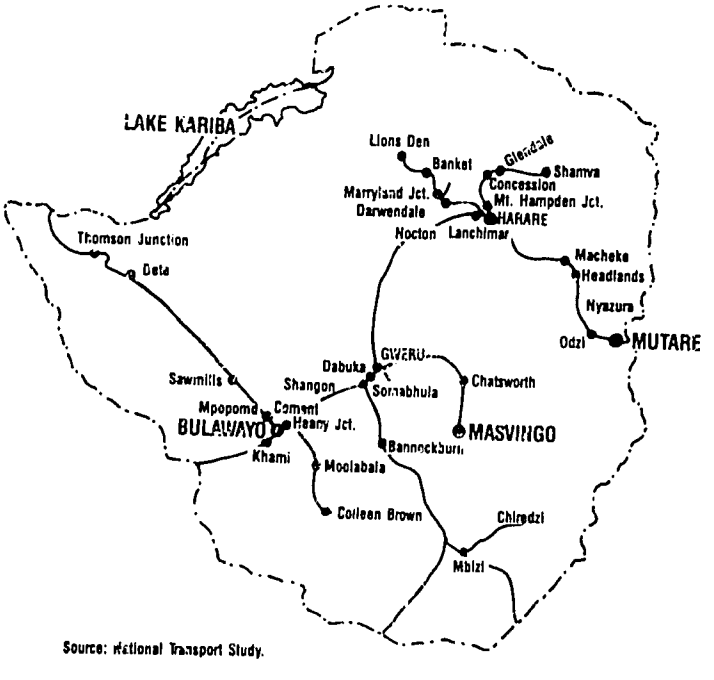
Although the Government is not involved in the marketing of fertilizers, it sometimes intervenes in situations where shortages of some fertilizer have occurred. For instance, the Government may direct that sales of urea be confined only to large-scale commercial farmers

as a source of nitrogen to ensure that available ammonium nitrate is used by peasant farmers.

However, since the Government is responsible for allocating foreign exchange to the fertilizer companies, the availability of fertilizer and its timely distribution are largely dependent on the levels of foreign exchange allocated and the time of allocation. Outside the allocation of actual foreign exchange for importing fertilizers, there exists a system of acquiring fertilizers through barter or counter trade. This form of trade is often time consuming and can result in delays in procuring fertilizer materials, which in turn present a logistical problem in marketing.

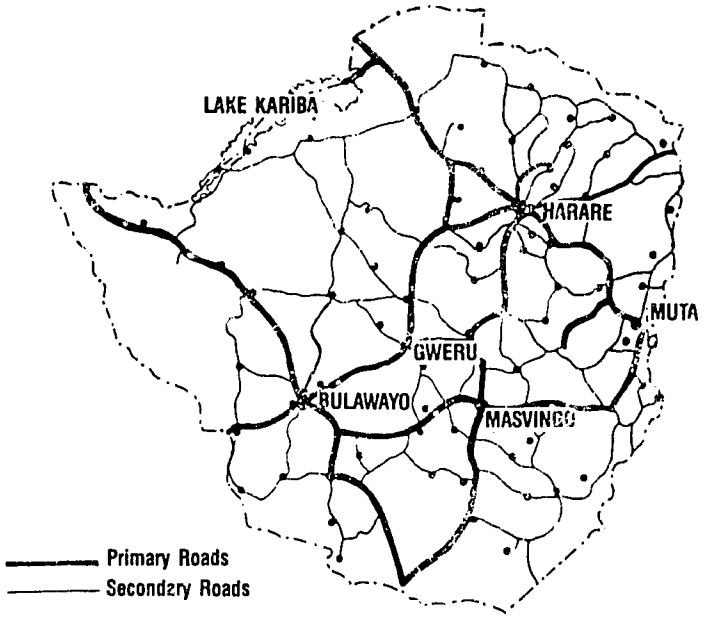
The major problem associated with the marketing of fertilizer is historical and infrastructural. Historically, development has taken place along major communication lines; thus, some peasant farming areas by virtue of their location are poorly serviced with transportation and storage infrastructures. The fertilizer distributors do not have sales depots located in the various parts of the country. Therefore, all sales are made directly from their Harare factories. The movement of fertilizers from the distributors' factories to consumers is the responsibility of the purchaser who has to arrange for the collection and transportation of the fertilizer. This transport is by road and rail. Figures 2 and 3 show the rail and road networks in Zimbabwe.

It will be noted that both road and rail networks follow the major areas of commercial activity. The main commercial farming areas are well serviced by the existing rail and road transport systems.



Source: National Transport Study.

Figure 2. **Zimbabwe Rail Network 1984.**



Source: National Transport Study.

Figure 3. **N.T.S. Proposal for Primary and Secondary Roads.**

According to a National Transport Study, the roads in the peasant sector are "rather neglected, most of them being gravel or earth roads." It is clear therefore that the infrastructure in the communal rural areas is not well developed, and farmers in these areas would have to travel long distances to collect fertilizers if there were no cooperative societies and private traders.

Although cooperative unions have had problems, particularly with complaints from farmers who feel that they take large marketing margins, they hold the best promise of eventually removing the constraints of marketing in communal areas.

Another fertilizer source nearer to the communal farmers is the private traders servicing both communal and commercial agriculture. They mostly operate on a cash-and-carry basis, and their prices are free on rail plus a markup to recover the cost of transport and storage and a profit element.

The Government also has a policy of developing what are known as "rural growth points," which are intended to become centers of commercial activity at the district level. This is part of the Government's objective of decentralization. The growth points will have all the basic infrastructure and support services such as good roads, electricity, and banking facilities. Hopefully, this will encourage fertilizer companies to build warehouses and distribution points at these centers and thus bring fertilizers closer to the farmers.

Table 4. **Economics of Fertilizer Use, 1987 Prices**

Crop	Total Fertilizer Cost	Yields: With Fertilizer	Yields: Without Fertilizer (Estimate)	Yields: Increment	Producer Price	Value of Yield Increment	Net Income From Fertilizer Use
	(Z$/ha)	(tonnes/ha)			(Z$/tonne)	(Z$/ha)	(Z$/ha)
Maize	271.92	5.60	2.6	3.00	180.00	540.00	268.08
Wheat	408.30	5.00	2.50	2.50	300.00	750.00	341.70
Soybeans	149.63	2.50	0.650	1.85	340.00	629.00	479.37
Sorghum	189.26	0.60	0.40	0.20	180.00	36.09	-153.26
Cotton	184.41	1.80	1.00	0.80	670.00	536.00	351.59

Source: IFDC; Ministry of Lands, Agriculture and Rural Resettlement.

Fertilizer Demand and Related Problems

Fertilizer demand is influenced to a large extent by the maize crop, which is the major crop receiving fertilizer. The economics of fertilizer use are analyzed for selected crops in Table 4 based on large-scale commercial farming production costs. Soybeans, wheat, and cotton appear to achieve greater profitability from the use of fertilizers than does maize at 1987 prices, largely because the Government has held down the producer prices for maize for the last three seasons. This was intended to bring about a reduction in the large stocks of maize that had accumulated following the 1985/86 bumper harvest. Clearly, farmers' use of fertilizer, and therefore overall demand for fertilizers, depends on the incremental responses to additional applications of fertilizer and the producer crop price that the Government pays for each crop.

Soil fertility experiments are conducted by the Chemistry and Soil Research Institute of the Department of Research and Specialist Services. Fertilizer application rates and nutrient requirements are based on these tests. The Tobacco Research Board also conducts a soil testing service for tobacco producers.

The Department of Agricultural, Technical, and Extension Services (AGRITEX) is the extension wing of the Government. AGRITEX offers advice to farmers on the use of fertilizers in conjunction with other complementary inputs such as seeds and pesticides.

AGRITEX has compiled a Farm Management Handbook, which shows recommended application rates for fertilizers and chemicals for each crop under the different agroecological conditions. One of the major drawbacks to the efforts of the Extension Service has been the lack of sufficient extension workers to cover the communal sector, which has a large number of farm families. It is Government's policy to improve the ratio of extension workers to farmers.

Training colleges and institutes in the country are sufficient to meet Zimbabwe's requirements. At present up to 1,000 students are trained, an increase of 300% from only 340 students in 1980. There are two agricultural colleges and four institutes compared with two colleges and two institutes in 1980. Considerable policy changes have been made in the agricultural education system to reflect changes in national agricultural policy and to give more emphasis to communal agriculture.

Role of Credit

The large increase in the use of fertilizer by small-scale farmers in 1980/81 (see Table 5) was due to aid programs and crop packages that became available to farmers. Since then, however, the availability of seasonal credit has played the most significant role in determining the level of sales of fertilizer to the small-scale subsector.

Table 5. **Fertilizer Sales by Type of Farmer**

Season	Large-Scale Subsector	Small-Scale Subsector	Total
	('000 tonnes)		
1979/80	328	27	355
1980/81	401	90	491
1981/82	436	96	532
1982/83	372	98	470
1983/84	361	109	470
1984/85	315	115	430

Between 1980 and 1984, credit to small-scale farmers from the Agricultural Finance Corporation (AFC) for the purchase of fertilizer increased from Z$1 million to Z$16.2 million. The trend toward increased sales of fertilizer to the small-scale subsector is therefore consistent

with the rise in the amount of seasonal credit available over the years.

In order to obtain a loan from the AFC, a farmer submits an application; if it is approved, a buying order is sent to the farmer and to the designated supplier of the fertilizer. At the same time, a stop order is also sent to the agency to whom the farmer sells his crop. This could be the Grain Marketing Board or the cooperative union, etc. The farmer obtains his fertilizer upon presentation of the buying order to the supplier, and when he sells his crops, the stop order is executed and the appropriate deductions for the cost of the fertilizer and the loan are made. There is a link therefore between the supply of fertilizer and the sale of crops that ensures an acceptable rate of recovery by AFC (Table 6).

Table 6. **Short-Term Credit Extended to Farmers, 1980-86**

Year	Commercial Bank Advances	Agricultural Finance Corporation	Agricultural Cooperatives and Other Companies	Total
	(Z$ '000)			
1980	55,961	61,461	46,653	164,075
1981	54,084	61,943	63,844	179,871
1982	79,469	84,239	65,003	228,711
1983	97,622	124,211	82,403	304,236
1984	106,022	142,952	84,187	333,161
1985	109,458	148,599	112,810	390,867
1986	149,482	166,834	124,232	440,548

Source: Central Statistical Office.

Pricing and Marketing of Crop Output

Producer prices for controlled crops such as maize, wheat, soybeans, sorghum, groundnuts, sunflower seed, coffee, cotton, and millet are determined by Government. The prices offered to farmers for these products are postplanting prices. Pricing policy to an extent determines the Government's ability to reconcile production trends with market circumstances. Producer and selling prices for controlled agricultural products are both fixed by the Government.

The process starts at the beginning of each year with consultations between producers and the Ministry of Lands, Agriculture and Rural Resettlement. In these consultations, all parties concerned have an opportunity to make a detailed appraisal of production plans, consumption patterns, stock levels, input supply, transport capacity, and impact on consumer prices, wages, and farm incomes.

The Ministry of Lands, Agriculture, and Rural Resettlement then makes a recommendation to Cabinet on a pricing package that is believed to meet the aspirations of both Government and producers.

Government prefers postplanting prices as opposed to preplanting prices. Prices announced at the beginning of the planting season, that is preplanting prices, would invariably fail to adequately reflect the numerous changes that take place during the production process such as changes in input costs, incidence of drought and pests, and changes in the demand situation.

The marketing and distribution of crop output is undertaken by Marketing Boards. The Grain Marketing Board is responsible for the purchasing from farmers and marketing of maize, wheat, soybeans, sunflower seed, groundnuts, sorghum, coffee, and millet. The Cotton Marketing Board is responsible for milk, milk products, and cold storage.

Most of the marketing boards incur losses on their operations, and it is Government policy to gradually remove subsidies to the Boards. The Government recognizes that as a matter of policy it would not be desirable for the Boards to become fully commercialized because they also play a development role.

Policy Measures to Overcome Existing Constraints in the Marketing System

Fertilizer use at farm level is determined by the expected profits from its use. The expected profit depends also on a number of other variables such as crop prices, fertilizer prices, crop response to fertilizer, and the associated costs of using fertilizers. All these factors may serve as serious constraints to fertilizer use expansion. These constraints may either reduce the profitability of fertilizer use or prohibit the farmer from obtaining potential profit. In the context of Zimbabwe, small-scale farmers tend to be faced with more severe constraints than the large-scale farmers. The Government has to design sound policies based on knowledge of these constraints.

The present system of input supply in the country was largely designed to cater to the large-scale commercial farmers in more strategic regions. As a result, the marketing and input supply services provided by the present system are most costly and unreliable for the communal area farmer. Studies by the Farm Management Research Section of the Ministry of Lands, Agriculture, and Rural Resettlement have indicated that crop marketing costs account for only 5% of total variable costs (TVC) for the average commercial farmer, whereas these costs account for 25% of operating costs for the average communal farmer.

In a study conducted by FAO on marketing margins, it was revealed that transport costs are very high, especially in the peasant sector. The average costs compare as follows: Z$16.00/tonne or Z$0.80/bag in large-scale commercial areas and Z$54.00/tonne or Z$2.70/bag in the communal and small-scale farming areas. The retail margin was also identified as a major cost component. The high cost in the peasant sector is attributed to market infrastructure. Distribution efficiency can be improved if the Government devotes a substantial proportion of national resources towards the provision of infrastructure.

As discussed earlier, Zimbabwe, like most developing countries, depends on imports to meet part of the domestic fertilizer demand. It is desirable therefore for the Government to look at expanded domestic production where this is possible and economical.

The use of fertilizer is most productive when it is applied with other complementary farm inputs, which should also be made available at the right time, place, and price. Because the Government allocates foreign exchange for the importation of these inputs, there is a need for a more coordinated assessment of input requirements so that the availability of improved varieties of seeds is complemented with sufficient availability of fertilizer and pesticides for instance.

Zimbabwe needs to adopt also a more long-term or medium-term approach when forecasting fertilizer requirements in future years. The present approach involves determination of fertilizer requirements on a year-to-year basis by a committee chaired by the Ministry of Lands, Agriculture and Rural Resettlement. It would be ideal, in addition to this system, to estimate fertilizer requirements on a medium-term basis. As a start, the five-year National Development Plan could be used so that whatever agricultural production targets are indicated in the Plan can be related to input requirements to achieve those targets. This will also assist Government in the implementation of policies that seek to expand services available to farmers, namely, research, extension, and credit.

Appendix 1. Domestic Fertilizer Prices (Zim $/tonne) for the Years 1975 to 1986

Year (March-February)	Straights										Compounds							
	Nitrogen				Phosphate		Potash		Ground									
	AM	Urea	Nitrate of Soda	Ammonium Sulfate	Double Superphosphate	Single Superphosphate	Potassium Sulfate	Muriate of Potash	Dolomite	Gypsum	A	B	C	D	L	M	S	Z
1975/76	127.4		156.2		92.8	43.8	143.4	118.4	14.4	21.8	100.2	107	94	91.4	94.4	98.2	98.8	109.2
1976/77	116.4		153	75	117.6	57.4	130.6	99.2	13.4	23.4	110.8	117.2	105	99.4	102.2	95.2	100.4	116.4
1977/78	129.4		170.2		138	63	119.6	89.8	14	25.2	114.6	122.4	126.6	106	92.2	99	106.8	123
1978/79	130.8		163.4		149.8	67.6	125.4	91.6	14	26.2	123.2	131.6	136	114.2	98.8	106.4	114.8	126.6
1979/80	141.6		214	113.8	173	76.2	166.2	121.6	15.6	29	146	155	158.6	128.2	112.2	117.8	130	140.2
1980/81	168.2		220.4		204.4	90.4	201.8	155.2	16.2	34.2	175	185.8	190.4	154	135	141.2	154	165.4
1981/82	187.2	249.6	257.6	167.6	230.4	117	238.6	103	18.8	38	201.6	211.4	214.4	168	188.8	166.2	180	181.6
1982/83	206.8	275.6	302.2		267.4	143.6	267.4	193.8		44.2	230.6	241.2	243.4	189.4	214.2	184.6	206.6	203
1983/84	206.8	275.6	302.2		267.4	143.6	267.4	193.8		44.2	230.6	241.2	243.4	189.4	214.2	184.6	206.6	203
1984/85	306.4	408.6	516.6		376	198.4	376			52.4	327.8	344	347.6	265.2	304.6	258.6	337.8	280.6
1985/86	400.6	541.4	609.8		479	256	536.4	351.8		55.4	443.2	465	467.8	355.6	404.1	350.8	448	371.2

Appendix 2. Volume and Value of Crop Sales to/Through Marketing Authorities From 1970 to 1986 (Volume in Tonnes, Value in Thousand Zim $)

Year	Maize		Groundnuts (Unshelled)		Sorghum		Soyabeans		Wheat		Cotton		Tobacco (Flue Cured)		Sunflower		Coffee	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
1970/71	610,686	24,674	11,637	844	3,190	112	7,348	628	56,235	4,032	99,039	14,044	51,399	21,722			615	491
1971/72	1,113,709	39,197	31,621	2,552	4,145	164	8,045	707	89,455	6,472	140,427	22,022	59,741	27,935			745	559
1972/73	1,420,725	43,313	81,173	7,092	22,865	947	8,461	704	81,626	5,822	170,727	28,617	60,892	29,953			1,601	7[illegible]
1973/74	550,363	25,406	26,528	3,183	25,818	1,159	7,976	1,102	85,975	5,961	135,796	34,653	67,980	37,130			1,580	1,109
1974/75	1,336,855	52,937	44,416	7,310	13,229	436	19,053	2,565	90,449	7,135	164,722	44,891	71,620	56,070			2,981	2,383
1975/76	1,006,922	46,518	44,707	6,074	4,641	182	27,920	2,088	128,752	14,198	163,066	35,598	83,920	57,733			3,837	3,344
1976/77	958,532	51,669	46,608	7,283	14,562	740	44,824	4,611	147,854	17,583	131,566	46,818	110,533	79,071			5,073	9,290
1977/78	941,065	48,649	12,497	2,838	14,036	1,028	44,103	5,919	171,134	20,821	148,006	49,997	83,374	67,974			3,625	8,727
1978/79	877,026	45,594	17,696	3,587	16,729	1,165	69,746	9,729	207,997	22,472	173,914	53,303	82,969	81,994			5,149	9,376
1979/80	511,921	30,882	12,714	3,400	19,892	1,505	80,999	11,853	158,940	18,110	166,830	54,871	111,685	92,023			4,106	10,565
1980/81	819,168	72,062	17,425	4,513	17,803	1,741	93,636	14,944	163,040	22,112	182,037	70,515	122,572	97,338			5,630	12,385
1981/82	2,013,758	239,778	20,037	5,312	30,393	3,182	65,319	11,069	200,904	34,735	200,904	76,752	69,795	127,527			4,964	7,417
1982/83	1,391,265	166,431	15,905	4,432	19,150	2,014	84,340	16,788	212,945	39,892	212,945	79,339	86,549	145,811			6,906	12,003
1983/84	616,749	73,753	9,329	2,591	5,347	582	74,438	19,123	124,250	27,296	124,250	83,413	94,295	177,797	4,726	1,162	9,727	20,886
1984/85	941,590	131,439	5,706	1,742	19,949	2,760	89,775	25,665	98,530	24,536	98,530	137,953	119,636	247,118	8,663	3,242	10,720	32,034
1985/86	1,827,768	326,990	7,858	3,582	81,981	14,083	85,512	27,223	205,528	58,320	205,528	193,213	107,712	284,524	14,083	4,151	11,354	43,914

Part II

Special Papers

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La Consommation d'Engrais en Afrique Sub-Saharienne: Analyse de la Croissance et Profil d'Utilisation

Gunvant M. Desai et Vasant Gandhi

Résumé

La situation des engrais en Afrique sub-saharienne est caractérisée par de très faibles niveaux et de très fortes variations dans l'utilisation de cet intrant. Cependant, la consommation totale a augmenté, passant d'environ 200 000 tonnes dans les années soixante, à près de un million de tonnes métriques au début des années quatre-vingt, ce qui représente un taux de croissance annuelle de 8,5 pour cent. Cette croissance a été instable et très variable.

Les fluctuations dans l'utilisation des engrais sont analysées sous l'angle (a) des différentes zones agroécologiques, (b) des caractéristiques historiques et structurelles, (c) des spécificités des schémas de culture, (d) des infrastructures et des efforts de développement, (e) des caractéristiques du commerce et de la dette, et (f) des particularités du secteur des engrais. Cette étude établit des corrélations d'essai mais utiles servant d'hypothèses préliminaires, et fournit des bases pour une analyse par pays plus approfondie des facteurs qui influent sur la consommation d'engrais et de leur rôle dans la production alimentaire et le développement agricole.

L'analyse des caractéristiques historiques et structurelles, montre que les pays anglophones consomment plus d'engrais que les pays francophones. Les variables de population et de densité ne montrent pas de corrélation avec l'utilisation d'engrais, il en est de même pour le produit national brut et le produit intérieur brut. Cependant, le taux de croissance du produit national brut par habitant montre un rapport positif, ainsi que la production totale de cé- réales par habitant et la production vivrière par habitant au niveau des populations rurales.

Les résultats concernant les schémas de culture montrent que la présence de plus de cultures céréalières est associée à de hauts niveaux de consommation d'engrais, tandis que celle des racines et des tubercules montrent une relation négative.

Les investissements gouvernementaux par hectare de terre arable restent le facteur le plus important qui conditionne l'adoption des engrais. En effet, le nombre de chercheurs agricoles par hectare de terre arable, l'étendue des zones irriguées, l'importance du réseau routier, et les zones mécanisées sont liés de manière positive et significative à l'utilisation des engrais.

Concernant les caractéristiques du commerce et de la dette, il existe une relation fortement négative entre le pourcentage d'importations alimentaires, le degré d'endettement, et la consommation d'engrais.

Pour ce qui touche au secteur des engrais, la présence ou l'absence de matières premières ne semble pas influencer la demande. Par contre, il n'est pas surprenant que la production locale et la subvention aient un effet positif sur l'utilisation des produits fertilisants.

Cette étude se termine par une analyse régionale de la croissance de la consommation d'engrais. Les fluctuations qui s'observent dans la demande par région s'expliquent par (a) le niveau de développement agricole, (b) les termes de l'échange, (c) le cot des importations d'engrais et du pétrole, (d) l'extension de la base de culture, (e) la diffusion du mas hybride, (f) la prévalence de la culture commerciale, (g) l'instabilité politique et (h) la sécheresse.

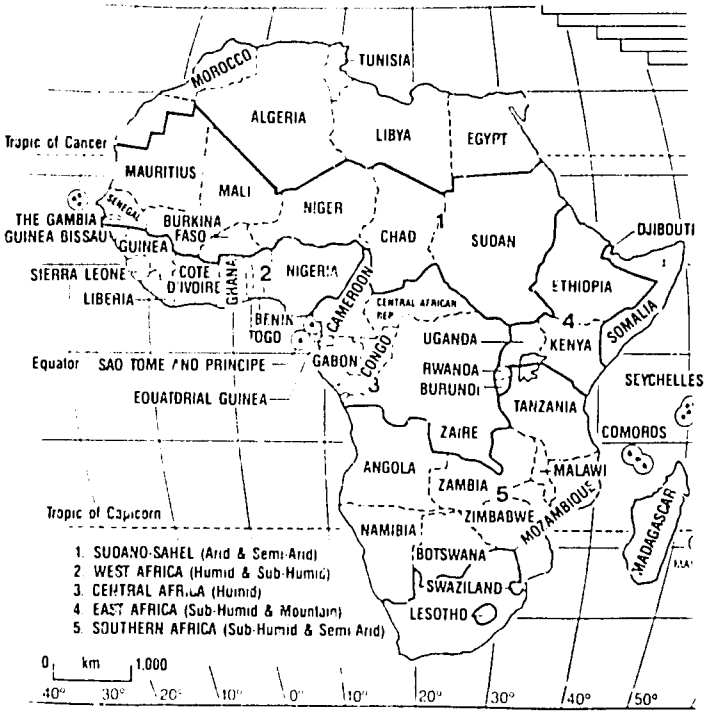
Fertilizer Consumption in Sub-Saharan Africa: An Analysis of Growth and Profile of Use

Gunvant M. Desai and Vasant Gandhi

Introduction

The importance of fertilizers in accelerating food production in sub-Saharan Africa[1] is well recognized by researchers and policymakers. Mellor et al. (1987) have given fertilizers the first functional priority in accelerating food production in sub-Saharan Africa and suggest that even under existing technology it should be feasible to achieve a 15% rate of growth in fertilizer consumption, which can have a very significant impact on food production.

The Food and Agriculture Organization of the United Nations (FAO) (1981), concluded in a study, *Agriculture: Towards 2000,* that 60% of the additional food production in developing countries required to meet the growing demand must come from increased yields. The study found that 55% of the increase in yields in developing countries during 1965-76 came from fertilizers and that there is a clear relationship between higher application of fertilizers and above-average agricultural production. For all of Africa, the study estimated that by the year 2000 fertilizer consumption needs to increase to 5.7 million tonnes in a "high" scenario and 4.1 million tonnes in a "low" scenario. This is a huge growth, especially when compared with the level of 0.16 million tonnes in the early sixties, which increased only to 0.95 million tonnes by the mid-seventies. FAO's estimates imply a growth rate of 6% to 7.4% from the mid-seventies to 2000 for all of Africa; the implied growth rate would be much higher for sub-Saharan Africa, which starts from a much lower base.



Source: FAO (1986).

Figure 1. **Sub-Saharan Africa: Map Showing Agro-Ecological Regional Delineation.**

In a study, "African Agriculture: The Next 25 Years," FAO (1986) investigated a scenario of feasible improved performance for African agriculture that would allow African crop and livestock production to expand at an annual rate of 2.9% from 1979-81 to the year 2010. It found that the bulk of this growth would have to come from increased yields, and that this would be impossible without a substantial increase in fertilizer use. This improved-performance scenario assumed a sixfold increase in the total fertilizer use, leading to a level of 44 kg/ha in sub-Saharan Africa. The average level of consumption in sub-Saharan Africa was 7 kg/ha in 1979-83.

In view of the fragile nature of sub-Saharan soils and the growing population pressure, Oram et al. (1979) point out that even to maintain the current low levels of yields, with restorative fallow being reduced due to population pressure, special measures will be required to stabilize soil fertility. The relative economics of both raising production through bringing more land under cultivation, as against raising yields, and the imperative of raising labor productivity point to the need for rapidly changing cultivation practices. Clearly, this will involve much greater fertilizer use.

All this points to the urgent need to rapidly increase fertilizer consumption in sub-Saharan Africa. What kind of policies are needed for this? To answer this question, it is obviously important to systematically examine the record of fertilizer consumption in sub-Saharan Africa

1. Table 1 gives the list of sub-Saharan African countries in this study, along with their population, total area, arable and permanent cropped land and fertilizer use per hectare in the early 1960s and the early 1980s. The countries are grouped into five agroecological zones based on FAO's classification in the *Atlas of African Agriculture*. The delineation of the regions is also shown in Figure 1.

Table 1. **Sub-Saharan Africa – Regions, Countries and Some Basic Data**

Agroecological Regions/Countries	Total Population 1980	Total Area 1980	Arable and Permanent Crop Land Area	Fertilizer Consumption Per Hectare of Arable Permanent Crop Land (1961-65) Average	(1979-83) Average
	('000)	('000 ha)	('000 ha)	------ (kg/ha) ------	
Sudano-Sahel (Arid)					
Burkina Faso	6,175	27,400	2,563	-	3.5
Cape Verde	300	400	40	-	2.2
Chad	4,477	125,800	3,150	-	1.3
The Gambia	583	1,100	156	0.4	14.8
Mali	7,009	12,200	2,050	-	5.7
Mauritania	1,631	103,100	195	-	6
Niger	5,311	126,700	3,552	-	0.8
Senegal	5,707	19,200	5,225	4.4	4.5
Somalia	4,612	62,700	1,066	0.8	1.1
Sudan	18,681	237,600	12,417	3.7	5.3
West Africa (Humid & Sub-Humid)					
Benin	3,472	11,100	1,795	0.2	1.5
Côte d'Ivoire	8,248	31,800	3,880	1	11.7
Ghana	11,458	23,000	2,760	0.6	7.8
Guinea	4,832	24,600	1,570	0.6	1.1
Guinea Bissau	808	2,800	285	-	3.4
Liberia	1,870	9,600	371	0.4	9.6
Nigeria	80,556	91,100	30,385	0.1	6.3
Sierra Leone	3,296	7,200	1,766	0.1	1.2
Togo	2,534	5,400	1,420	-	1.9
Central Africa (Humid)					
Cameroon	8,554	46,900	6,930	0.8	5.2
Central African Rep.	2,290	62,300	1,945	0.1	0.5
Congo	1,529	34,200	669	1.9	1.2
Equatorial Guinea	352	2,800	230	-	0.4
Gabon	1,074	25,700	452	-	2
Zaire	28,531	226,800	6,314	0.2	1.2
East Africa (Sub-Humid & Mountain)					
Burundi	4,052	2,600	1,305	-	1.1
Ethiopia	32,012	110,400	13,880	0.1	3
Kenya	16,766	56,900	2,270	9.6	29.2
Madagascar	8,704	58,100	3000	1.2	3.5
Mauritius	955	200	107	251.9	241.6
Rwanda	5,144	2,500	975	-	0.4
Uganda	13,179	20,000	5680	0.7	0.1
Southern Africa (Sub-Humid & Semi-Arid)					
Angola	7,722	124,600	3,500	1	3.3
Botswana	908	58,500	1,360	1.4	1
Lesotho	1,339	3,000	292	1.1	15
Malawi	5,969	9,400	2,320	2.3	14
Mozambique	12,095	78,400	3,080	1.9	10.2
Swaziland	557	1,700	189	31.2	104.2
Tanzania	18,867	88,600	5,160	1.1	5.4
Zambia	5,648	74,100	5,108	2.1	15.6
Zimbabwe	7,360	38,600	2,539	27.7	57.6

during the past two decades. Do the persistently low levels of fertilizer consumption in sub-Saharan Africa mean that the fertilizer scene has been stagnant?

An attempt is made in this paper to answer these questions with some results from an analysis of FAO data. It must, however, be noted that our analysis has just begun, and much remains to be done to draw firm conclusions. But even the tentative results seem to have a bearing on discussions of policy issues and still more importantly on the research agenda for an analytical understanding of the macro forces of growth in fertilizer use in sub-Saharan Africa.

A Brief Overview

The sub-Saharan fertilizer scene is characterized by very low levels and by extremely sharp variations in the levels of fertilizer use in most countries over time and also across countries in a given year. Fertilizer consumption in Sudan, for example, changed from 100 thousand tonnes in 1975 to 10 thousand tonnes in 1978. In 1979-83 fertilizer consumption in Mauritius was 240 kg/ha while in the Central African Republic it was barely 0.5 kg/ha.

It is this kind of sharp variation that underlies the average fertilizer consumption level of about 7 kg/ha for 1979-83 in sub-Saharan Africa. This is extremely low as compared with the developing countries' average of 49 kg/ha during the same period. Moreover, fertilizer consumption in sub-Saharan Africa has been growing more slowly than in the developing world as a whole. In the early sixties, sub-Saharan countries had a share of 3.9% in the total fertilizer consumption of all developing countries. By the early eighties, this had declined to 2.5%. That this share is very low is clear from the fact that sub-Saharan Africa has 20% of arable and permanent cropped land and 10% of the population of all developing countries. (Also see Zalla, Diamond, and Mudahar [1977] and Mudahar [1980].)

Notwithstanding these facts, available data clearly suggest that there have been appreciable changes in sub-Saharan Africa during the last two decades. Total consumption increased from about 200,000 tonnes in the early 1960s to about 1 million tonnes by the early 1980s. Given the low base, one may not find the 8.5% annual growth rate very satisfactory, but it still indicates some dynamism in growth of fertilizer consumption. More revealing is the fact that, whereas more than 30 sub-Saharan countries had average consumption below 3 kg/ha in the early 1960s, by the early 1980s the number of such countries decreased to 15.

Figure 2 shows, however, that the growth in total fertilizer consumption has not been steady, and further examination reveals that the growth has been highly variable in most of the regions and has fluctuated even more at the country level. As shown in the figure, growth was fairly steady and continuous from about the early sixties to the mid-seventies, except for a slight (perhaps, drought-related) slowdown around 1967-68. But thereafter, there was a major stalling of growth between the mid-seventies and 1979, apparently as a cumulative result of widespread droughts in sub-Saharan Africa in several of these years, deteriorating terms of trade, and a sharp decline in Zimbabwe due to civil war.

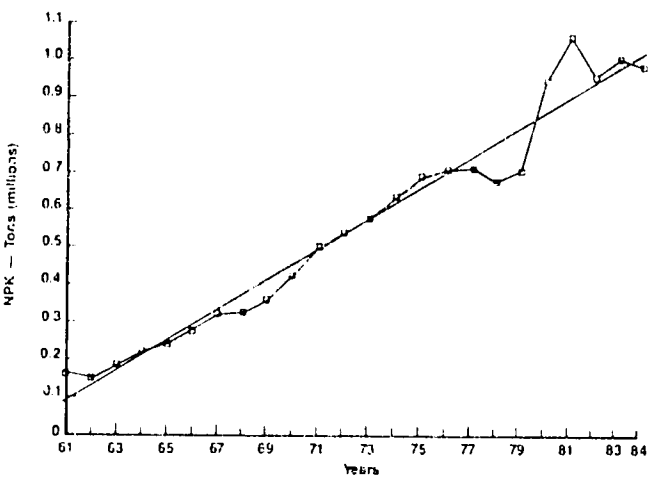


Figure 2. **Fertilizer Consumption – Sub-Saharan Africa.**

This period of stagnation was followed by a period of extremely rapid growth (1979-81), which restored fertilizer consumption to the long-term trend line (Figure 2). As further discussed below, this growth has been fairly widespread, and it was facilitated by good weather, oil revenues, and development measures in West Africa, especially Nigeria; better support service policies in East Africa, especially credit policies in Kenya; and a sharp post-civil-war recovery in Zimbabwe. Following this, however, there was a second period of stagnation from 1981 onwards, which was also fairly widespread. It seems to be associated with droughts and with the foreign exchange constraints in fertilizer imports created by the debt crisis. All this indicates a stepwise growth consisting of stagnation and intermittent growth. But this is not unique to sub-Saharan Africa or the developing world. What is, however, important is to recognize this feature of the long-term trend in analytically identifying the relative importance of different factors. Given the urgency of raising fertilizer consumption, the importance of this cannot be overemphasized.

Within the different subperiods, the growth rate in sub-Saharan Africa's total fertilizer consumption was 11.5% per annum in the 1960s and was statistically significant. It slowed to 6% per annum in the 1970s but was still statistically significant. Between 1980 and 1984, however, there was no growth, as shown in Figure 2.

Variation in Levels of Consumption Across Countries

The main purpose in this section is to scrutinize the wide variations in fertilizer use across countries and to see whether the variation confirms expected patterns, particularly those with respect to major issues raised in the literature.

Fertilizer use is examined on the basis of a 5-year average to get a more dependable pattern in the cross-sectional variation in levels of fertilizer use, given the sharp year-to-year fluctuations in use revealed by the data. The period of 1979 to 1983 is used to get a recent picture, and total fertilizer consumption is divided by the arable and permanent cropland area of each country.

One quick way to "identify" the factors associated with the cross-sectional variation in levels of fertilizer consumption is to compute the correlation coefficients between levels of fertilizer use and each of the factors. This computation can also provide a measure of the statistical significance of the relationship, thereby helping to differentiate weak associations from strong ones. To obtain measures representative of sub-Saharan Africa, a weighted correlation procedure is used; the weights are the arable and permanent cropped land area of each country in sub-Saharan Africa.

The factors with respect to which the variation is examined are grouped into the following broad categories: agroecological zones, historical and structural characteristics, crop pattern characteristics, development effort and infrastructure, trade and debt characteristics, and fertilizer sector characteristics.

Agroecological Zones

After studying the agroclimatic conditions and the ecologies of the different countries, the FAO grouped the countries of sub-Saharan Africa into five broad agroecological zones: the Arid and Semiarid Sudano-Sahel Region, Humid and Subhumid West Africa, Humid Central Africa, Subhumid and Mountain East Africa, and Subhumid and Semiarid Southern Africa.

A test was conducted to determine if the levels of fertilizer use in the different countries differ significantly by the agroecological zones. A dummy variable procedure was used, which is equivalent to an analysis of variance framework (see Green, 1978), because correlation analysis was not appropriate here. The results are given in Table 2. The fact that the F-statistic is significant shows that fertilizer use may be significantly associated with the agroecological zones. However, among the measures of difference of individual zones, only the t-statistic for southern Africa is significant, showing that the fertilizer use in southern Africa is significantly higher with an average level of 14.9 kg/ha. This is the principal reason for the overall significance of the zonal difference in the test. Among other regions, only central Africa shows a much lower level of use of 1.04 kg/ha, but even here the t-statistic is not significant. It may also be noted that the R^2 with respect to agroecological zones is fairly low at 0.25, indicating that much of the variation cannot be explained by the agroclimatic conditions. A partial explanation may be that the present fertilizer use levels across sub-Saharan Africa are very low compared with "potential" levels based on agroecology, and thus large variations in the levels are a result of other factors raising or lowering fertilizer consumption. This is important to note because such low levels of use imply that only a fraction of the land is fertilized. The agroecology of that fraction of land receiving fertilizers may not be adequately captured by the broad agroecological classification used by the FAO.

Historical and Structural Characteristics

This section examines the association of fertilizer use with some historical and structural characteristics. The results of correlation analysis are given in Table 3. The results show, with high statistical significance, that anglophone countries have a higher level of fertilizer use than do francophone countries. This finding highlights the importance of "initial conditions" with respect to historical and structural characteristics in understanding forces that govern the growth in fertilizer use. Identifying those initial conditions requires further examination, but the differences could be due to the legacy of infrastructure development, the role of agriculture in the economy, and differences in governmental administration. The population density variables (per hectare of arable and permanent cropped land) do not show a significant association with fertilizer use. Thus the test is unable to support, at the country level, McIntire's (1985) proposition that population density is a major force behind higher fertilizer use levels. The weak negative signs may be a result of lower population densities creating conditions more conducive to a shift from subsistence farming to relatively large-scale commercial farming, and this in turn may lead to higher levels of fertilizer use. Fertilizer use is a relatively neutral technological change, neither significantly labor using nor labor saving (Binswanger, 1974).

Table 2. **Patterns of Fertilizer Use Per Hectare: Relationship With Agroecological Zones**

Zones	No. of Countries	Dummy Coefficient	Implied Mean Level of Use (kg/ha)	t-Statistic	F-Statistic	Statistical Significance	R^2
					2.83	**	0.25
Sudano-Sahel	10		4.79				
West Africa	9	0.30	5.09	0.10			
Central Africa	6	-3.75	1.04	-1.26			
East Africa	6	0.73	5.52	0.15			
Southern Africa	8	10.12	14.91	2.88		***	
(Intercept)		4.79					

Notes:
1. The fertilizer use data is a 5-year average over 1979-83.
2. Per hectare implies per hectare of arable and permanent cropped land.
3. The sample excludes Mauritius and Swaziland, which are small atypical countries that have very high levels of fertilizer use primarily due to sugarcane plantations.
4. For greater representational accuracy, the computation is done through a weighted estimation procedure, the weights being arable and permanent cropped land in each country.
5. See Appendix 1 for data notes and sources.
6. Statistical significance:
   *** Significant at 99% level.
   ** Significant at 95% level.
   * Significant at 90% level.

Table 3. **Patterns of Fertilizer Use per Hectare: Relationship With Historical and Structural Development Characteristics**

Characteristic	Number of Countries in Test	Correlation Coefficient	t-Statistic	Statistical Significance
Anglophone countries (Dummy)	39	0.68	5.57	***
Francophone countries (Dummy)	39	-0.59	-4.40	***
Rural population per hectare	39	-0.13	-0.82	
Total population per hectare	39	-0.11	-0.66	
GNP per capita	39	-0.07	-0.40	
GNP per capita growth rate	34	0.28	1.66	
% GDP from agriculture	34	-0.002	-0.01	
Major food-crop production per capita of rural population	37	0.30	1.86	*
Major food-crop production per capita of total population	37	0.35	2.24	**

Notes: See Table 2.

Whereas GNP per capita shows no association, the growth rate in GNP per capita shows a positive relationship, though not significant. This indicates some association between the growth performance of the economies and their levels of fertilizer use, possibly through higher productivity in agriculture. The share of agriculture in the GDP shows no relationship, possibly because the relatively high importance of petroleum and minerals in the economies of some countries decreases the share of agriculture. However, the per capita production of major food crops in cereal equivalents has a statistically significant and positive association with fertilizer use levels, indicating that countries that use more fertilizers may also be those that are able to produce more food per capita. The positive relationship with major food crops production per capita of rural population, considering rural

population a proxy for the rural labor force, shows that the rural labor productivity may be higher in countries that use more fertilizers.

Crop Pattern Characteristics

Table 4 shows the prevailing overall cropping pattern in sub-Saharan Africa. The correlation results are given in Table 5. The results show that the presence of more cereals in the cropping pattern is associated significantly with higher levels of fertilizer use, whereas root and tuber crops are negatively associated with fertilizer use. Pulses also show a negative association, but this is not significant.

Table 4. **Cropping Pattern in Sub-Saharan Africa, 1979-81**

Roots and Tubers	% Harvested Area
Cereals	46.7
Wheat	1.0
Rice	4.2
Maize	12.5
Sorghum	14.2
Millets	14.7
Pulses	10.2
Roots and tubers	11.1
Coffee	3.3
Cocoa	3.2
Tea	0.1
Cotton	2.8
Groundnut	5.6
Tobacco	0.03
Sugarcane	0.06

Note:

1. Harvested area is 75% of the arable and permanent cropped land in sub-Saharan Africa.

Among the cereals, maize shows a strong positive association indicating that it may be an important food crop with respect to fertilizer use in sub-Saharan Africa. Wheat also shows a significant positive association, but this is fairly weak probably because of the extremely limited area under wheat (1%) and the unsuitable agroclimatic environment for wheat in most regions. Millet, sorghum, and rice show weak negative associations, none of them statistically significant. These associations could reflect the current relative response ratios of these crops in sub-Saharan Africa, and possibly the price environment for these different crops. (See Vadlamundi and Thinim [1974] and Mwangi [1978] particularly for maize.) Coffee, cocoa, and tea surprisingly show a negative association, but this is not significant. Cotton shows a weak positive association, whereas groundnut, an important cash crop, shows a significant positive association. On an overall basis, neither the food crop, the nonfood crop, or the export crop area is significantly associated with higher levels of fertilizer use. The latter result, in particular, does not support a common belief that fertilizer use is heavily oriented toward nonfood and export crops. It appears from the results that nonfood and export crops may have a high per unit level of use, but over a very small and limited base. Consequently, per hectare use at the national levels becomes relatively high only when the use spreads to food crops. Some countries seem to have achieved this, whereas others have not. This result indicates that even at the present low level, relatively high average levels of fertilizer use can be attained if the cropwise base generating growth in fertilizer use is broadened to encompass food crops that occupy the bulk of the cropland. The experience of Asia, even before the advent of high-yielding varieties, clearly reveals this.

The most significant correlation is between fertilizer use and cereal yields, which gives a strong positive association. This correlation is indicative of the important role that fertilizers can play in increasing food, particularly cereal production, in sub-Saharan Africa. Other results indicate that this correlation may be to a large extent due to maize. Maize is considered by FAO to be suitable for adoption over large parts of sub-Saharan Africa. Thus, expansion in the maize area could facilitate the acceleration of fertilizer consumption.

Development Effort and Infrastructure

Table 6 shows correlation coefficients between fertilizer use level and some variables measuring development effort and infrastructure. One of the very strong correlations is the high and highly significant one between the level of government expenditure per hectare of arable and permanent cropped land and the level of fertilizer use. It shows that a strong commitment by the government to agricultural development plays an extremely important role in enhancing fertilizer use. The percentage of government expenditure on agriculture is positively but not strongly related. This indicates that it is the real magnitude of commitment per hectare that is important. These results, however, are based on only a small sample of 14 countries because of data limitations.

The number of agricultural research scientists per hectare also has a strong positive relationship underscoring the importance of agricultural research in increasing levels of fertilizer use. This shows the problem, cited by Idachaba (1980), of having an inadequate research staff too thinly spread over an unrealistic number of projects.

Table 5. **Patterns of Fertilizer Use per Hectare: Relationships With Characteristics of Agricultural Production**

Characteristic	Number of Countries in Test	Correlation Coefficient	t-Statistic	Statistical Significance
% Cereal area	36	0.24	2.08	**
% Rice area	36	-0.02	0.14	
% Wheat area	36	0.32	1.96	*
% Maize area	36	0.41	2.60	**
% Sorghum	36	-0.06	-0.37	
% Millets	36	0.05	-0.28	
% Roots and tubers area	36	-0.40	-2.51	**
% Pulses area	36	-0.20	-1.16	
% Coffee, cocoa, and tea area	36	-0.22	-1.29	
% Cotton area	36	0.08	0.48	
% Groundnut area	36	0.32	1.94	*
% Area in food crops	36	0.11	0.62	
% Area in nonfood/export crops	36	-0.11	-0.62	
Cereal yield	38	0.50	3.48	***
Coefficient of variation of cereal production	38	-0.36	-2.31	**

Notes:
1. The fertilizer use data is a 5-year average over 1979-83.
2. Per hectare implies per hectare of arable and permanent cropped land.
3. The sample excludes Mauritius and Swaziland, which are small atypical countries that have very high levels of fertilizer use primarily due to sugarcane plantations.
4. For greater representational accuracy, the computation is done through a weighted estimation procedure, the weights being arable and permanent cropped land in each country.
5. See Appendix 1 for data notes and sources.
6. Statistical significance:
   *** Significant at 99% level.
   ** Significant at 95% level.
   * Significant at 90% level.

Table 6. **Patterns of Fertilizer Use Per Hectare: Relationships With Development Effort and Infrastructure Characteristics**

Characteristic	Number of Countries in Test	Correlation Coefficient	t-Statistic	Statistical Significance
Government expenditure on agriculture per hectare	14	0.94	9.32	***
% Government expenditure on agriculture	14	0.33	1.23	
Agricultural research scientists per hectare	32	0.44	2.70	**
Agricultural personnel per hectare	36	-0.13	-0.76	
Foreign concessional assistance to agriculture per hectare	38	-0.37	-2.35	**
% Irrigated area	34	0.28	1.67	
% Mechanized area	39	0.60	4.50	***
Length of road network per hectare	18	0.73	4.32	***

Notes: See Table 5.

The agricultural personnel per hectare, however, is not strongly related, which perhaps indicates that just having agricultural personnel without the support of a strong research system and having staff in numbers only but without proper training will probably not work in enhancing input use and food production.

The negative sign on the foreign concessional assistance variable indicates that much of the concessional assistance is going to countries with very low levels of fertilizer use. It is difficult to comment on this without information on whether such assistance is inducing indigenous efforts to develop agriculture. However, it does indicate that commitment to agriculture as reflected in government expenditure per hectare is far more important than foreign assistance. The irrigated area variable is positively related but is not very strong probably because of data and measurement problems with the FAO irrigation data. Most of the irrigation data for sub-Saharan Africa do not capture the private/smallholder/tube well irrigation that is increasing (FAO, 1986a,b). On the other hand, the weak correlation could be taken as an indicator of significant fertilizer use on unirrigated land in some countries. The correlation between fertilizer use and the percentage of mechanized area, however, is extremely significant. Perhaps this could be due to a significant proportion of the fertilizer use being concentrated on large mechanized farms in sub-Saharan Africa. The correlation may also indicate that modernization of farm practices probably faces a labor shortage in sub-Saharan Africa, and where the modernization has made progress, it has probably been by overcoming this constraint through mechanization. This result supports the contention of some researchers (e.g., Nagy et al., 1987) that farm power and labor represent real constraints in the modernization of agriculture in sub-Saharan Africa.

The length of road network per hectare emerges as another very strong variable indicating clearly the great importance of infrastructure development. Better road network not only reduces the cost of transportation but also facilitates a whole set of other development processes that, in turn, facilitate the diffusion of fertilizer use over a larger area.

Trade and Debt Characteristics

Trade and debt characteristics have important associations with levels of fertilizer use (Table 7). The results show a strong negative association between percentage of food imports and fertilizer use indicating that the countries that use less fertilizer have large food imports. Whether this is due to constraints on foreign exchange availability for fertilizer imports or availability of concessionary food imports cannot be ascertained without further research. If it is the former, the question of the relative economics of food versus fertilizer imports becomes relevant, an argument frequently used against fertilizers in sub-Saharan Africa.

The relationship with dependence on agricultural exports is positive but not significant. This shows that, even among countries that depend heavily on agricultural exports, many have not made enough effort to raise fertilizer use.

The degree of indebtedness has a strong negative association confirming that, given the high import dependence for fertilizer supplies, debt burdens may be serious problems in the governments' commitment to efforts required in raising fertilizer use. What is important to note, however, is that fertilizer imports alone form a very

Table 7. **Patterns of Fertilizer Use per Hectare: Relationships With Trade and Debt Characteristics**

Characteristic	Number of Countries in Test	Correlation Coefficient	t-Statistic	Statistical Significance
Food imports as % of total imports	39	-0.48	-3.32	***
Agricultural exports as % of total exports	36	0.25	1.50	
Debt as a % of export earnings	37	-0.39	-2.48	**
Debt per hectare	37	-0.04	-0.25	
Landlocked countries (Dummy)	39	0.29	1.88	*

Notes:
1. The fertilizer use data is a 5-year average over 1979-83.
2. Per hectare implies per hectare of arable and permanent cropped land.
3. The sample excludes Mauritius and Swaziland, which are small atypical countries that have very high levels of fertilizer use primarily due to sugarcane plantations.
4. For greater representational accuracy, the computation is done through a weighted estimation procedure, the weights being arable and permanent cropped land in each country.
5. See Appendix 1 for data notes and sources.
6. Statistical significance:
   *** Significant at 99% level.
   ** Significant at 95% level.
   * Significant at 90% level.

small proportion of the import bills of most countries. Consequently, the policy to reduce fertilizer imports saves little foreign exchange, and this policy could result in large increases in the food import bills. Fertilizer supplies probably suffer greatly from the general irrational cuts that are imposed by governments in a foreign exchange crisis. This is not uncommon in the developing world and can be traced to inadequate appreciation of the role of the supply side in raising fertilizer use rapidly (Desai and Stone, 1987b). The results also show that trade problems in landlocked countries do not seem to cause a major problem in enhancing fertilizer use. This may be because landlocked countries are conscious of these problems and have devised ways and means to solve them after they have made a commitment to develop agriculture through fertilizer use. In fact, with some significance, landlocked countries have a higher level of fertilizer use than do countries with access to the sea.

Fertilizer Sector Characteristics

This section examines associations between levels of fertilizer use and a few fertilizer sector characteristics among sub-Saharan countries. The results are given in Table 8. The presence or absence of raw materials does not seem to influence fertilizer consumption. Without their use in fertilizer production, mere availability of raw materials cannot be expected to influence levels of fertilizer use.

In contrast, fertilizer production is positively and significantly associated with levels of use. To some extent this may be a supply response to effective demand for fertilizers. But to a large extent this may also be a result of efforts to create demand by the domestic production systems. This process has been observed in many parts of the developing world, most notably in China, India, Indonesia, Pakistan, and Bangladesh. Again, this is consistent with the argument that supply side plays a more decisive role in raising fertilizer use than has been recognized in the literature (Desai 1987, and Desai and Stone, 1987 a,b).

Fertilizer subsidy also appears to have a significant positive association with the level of fertilizer use. This indicates that the question of the desirability of fertilizer subsidies may be more complex in sub-Saharan Africa than is generally understood. In an environment characterized by low response ratios and inadequate development of systems and infrastructures that facilitate growth in fertilizer use, fertilizer subsidies may be initially necessary. But the long-term solution is to develop systems that lower farmers' cost of using fertilizers by raising the responses of crops to fertilizer use, by lowering the transport costs, and by removing the constraints to the use of complementary inputs (see Nagi et al., 1987 and Falusi, 1987). Even in the current context, more research is necessary to evaluate the effects of subsidies on the processes that affect growth in fertilizer use.

From the above analysis, which at best is only indicative, it is clear that behind the vast cross-sectional variation in fertilizer consumption among sub-Saharan countries there are numerous factors, and much more intensive research is needed to arrive at firm conclusions. Hasty generalizations, however plausible, cannot be a guideline for policies to increase fertilizer use rapidly. All that one can say at this stage is that even at such low levels a variety of macro factors seem to be relevant, far more than perhaps one would have assumed on a priori grounds.

Table 8. **Patterns of Fertilizer Use per Hectare: Relationship With Fertilizer Sector Characteristics**

Characteristic	Number of Countries in Test	Correlation Coefficient	t-Statistic	Statistical Significance
Countries with fertilizer raw material – including oil & gas (dummy)	39	-0.14	-0.87	
Countries with fertilizer production (dummy)	39	0.33	2.16	**
Countries with fertilizer subsidies (dummy)	39	0.35	2.28	**

Notes:

1. The fertilizer use data is a 5-year average over 1979-83.
2. Per hectare implies per hectare of arable and permanent cropped land.
3. The sample excludes Mauritius and Swaziland, which are small atypical countries that have very high levels of fertilizer use primarily due to sugarcane plantations.
4. For greater representational accuracy, the computation is done through a weighted estimation procedure, the weights being arable and permanent cropped land in each country.
5. See Appendix 1 for data notes and sources.
6. Statistical significance:
   *** Significant at 99% level.
   ** Significant at 95% level.
   * Significant at 90% level.

Growth in Fertilizer Consumption in Different Regions

This section briefly reviews the time-series of fertilizer consumption in different agroecological regions of sub-Saharan Africa.

Sub-Saharan Africa is a vast subcontinent encompassing large differences in agroclimatic conditions. The Atlas of African Agriculture (FAO, 1986) has divided it into five broad agroecological regions: (1) Arid and Semiarid Sudano-Sahel, (2) Humid and Subhumid West Africa, (3) Humid Central Africa, (4) Subhumid and Mountain East Africa, and (5) Subhumid and Semiarid Southern Africa (excluding South Africa). The country compositions of these regions are given in Table 1, and a map depicts the delineation of regions (Figure 1).

Tables 9 and 10 present a broad comparative picture of the levels of fertilizer use, growth performance, and shares of fertilizer consumption of the different regions. Over the entire period (1961-84), West Africa had the highest rate of growth (15.6%). This was followed by Central Africa (8.9%), and all the remaining three regions had growth rates of about 6%-7%. Only West Africa had a higher growth during the 1970s[2] than during the 1960s, 17.1% compared with 15.2%. In all the other regions, the growth rate during the 1970s was substantially lower than in the 1960s. During the early 1980s (1980-84), only the Central region had a higher growth rate than in the 1970s, 8.9% compared with 4.3%. In all other regions, it was lower, becoming even negative in Sudano-Sahel and Southern Africa. Thus, after the 1960s, the growth rate of fertilizer consumption decreased in each of the succeeding periods in Sudano-Sahel, East Africa, and Southern Africa. This is significant considering that these regions have 57% of the arable and permanent cropped land and 55% of the population of sub-Saharan Africa.

The Western and Central regions had the lowest shares in the 1960s. With their relatively higher growth rates, the regional distribution of fertilizer consumption in sub-Saharan Africa had become less skewed by the early 1980s. The share of the Western region increased from 9% to 30%, whereas the shares of the Sudano-Sahel, East, and Southern regions declined. The regional coefficient of variation of consumption had declined from 66% in the early 1960s to 57% by the early 1980s.

2. The division of the 1961-1984 period into the three sub-periods the 1960s, 1970s, and early 1980s is arbitrary. Most SSA countries became independent in the late 1950s and the 1960s. Thus, most of them were newly independent nations in the 1960s. This was a period of much political struggle and also of initiation of development efforts in many countries. The 1970s was a period of the major oil shocks, which greatly helped some and harmed many. The early 1980s was marked by sharp declines in the terms of trade, an acute debt crisis, and some major droughts.

Table 9. **Fertilizer Consumption Growth in Sub-Saharan Africa**

Region	Statistic	Units	1961-1970	1970-1980	1980-1984	1961-1984
Sudano-Sahel	Mean Level	'000 tons	45.8	103.7	124.3	21.2
	Growth Rate		8.5	5.5	-2.4	6.7
	t-Statistic		4.8	1.9	-0.8	9.0
West Africa	Mean Level	'000 tons	25.1	121.3	301.1	
	Growth Rate		15.2	17.1	7.4	15.6
	t-Statistic		18.1	12.2	2.7	41.7
Central Africa	Mean Level		17.7	35.6	54.4	
	Growth Rate		21.8	4.3	8.9	8.9
	t-Statistic		23.0	2.8	5.2	10.8
East Africa	Mean Level	'000 tons	63.2	113.3	155.9	
	Growth Rate		10.3	2.3	2.1	5.9
	t-Statistic		18.4	3.2	0.7	14.7
Southern Africa	Mean Level	'000 tons	117.1	278.5	362.8	
	Growth Rate		11.1	3.8	-7.3	7.4
	t-Statistic		10.6	3.6	-3.9	12.2
Sub-Saharan Africa	Mean Level	'000 tons	268.8	652.3	998.5	
	Growth Rate		11.5	6.0	0.2	8.5
	t-Statistic		16.9	7.4	0.1	21.2

Table 10. **Important Fertilizer Consuming Countries in Sub-Saharan Africa by Agroecological Region, 1980-84**

Region	Consumption Shares (%)	Major Share Countries	Regional Consumption Shares (%)	Rank by kg/ha Consumption
Sudano-Sahel (arid)	12	Sudan	50	3
		Senegal	20	4
		Mali	11	2
			81	
West (humid and subhumid)	30	Nigeria	75	4
		Côte d'Ivoire	14	1
		Ghana	7	3
			96	
Central (humid)	5	Cameroon	77	1
		Zaire	16	3
		Gabon	3	2
			96	
East (subhumid and mountain)	16	Kenya	49	2
		Ethiopia	26	4
		Mauritius	17	1
			92	
Southern (subhumid and semiarid)	36	Zimbabwe	43	2
		Zambia	22	3
		Malawi	11	4
			76	

Table 10 presents the regional shares in consumption of fertilizers (1980-84) and the shares of the top three consuming countries in each region. In each region, one country alone accounts for 43%-77% of the fertilizer

consumption, and the top three countries account for 76%-96% of each region's consumption. The top three countries, according to total consumption, are also among the top four when ranked according to consumption per hectare of arable and permanent cropped land within each region.

Sudano-Sahel Region

The Arid and Semiarid Sudano-Sahel Region as defined by FAO consists of Burkina Faso, Cape Verde, Chad, The Gambia, Mali, Mauritania, Niger, Senegal, Somalia, and Sudan. Its fertilizer consumption is about 12% of sub-Saharan Africa (1980-84). It had a statistically significant but relatively low rate of growth of 6.7% (1961-84) with extremely large fluctuations (Figure 3). In the 1960s, the growth was fairly rapid until 1967. This was followed by a decline until 1970. After 1970, there was an unprecedented momentum of growth to 1975 with the fertilizer consumption increasing rapidly from about 50 thousand tonnes to 160 thousand tonnes. But this momentum slowed after 1975, and consumption declined to 85 thousand tonnes in 1978-79. This unusual time path needs study. It seems to have much to do with events in Sudan. There was some recovery in 1980-81 but a decline again in 1983 followed by another rise in 1984.

The fertilizer consumption in Sudano-Sahel is, in reality, dominated by Sudan, Senegal, and Mali. The temporal variation in fertilizer consumption in the Sudano-Sahel region appears to be largely due to policies and prospects of the major export crops of cotton and groundnut and the import policy for fertilizers. Irrigation plays a major role in expansion of fertilizer use, especially in Sudan where policies towards these crops and fertilizer imports are supportive. Droughts seem to have a major effect in Senegal and Sudan, but not in Mali. Diversification of the crop base for fertilizer use may bring more stability in fertilizer use and thus improve the prospects for growth in consumption.

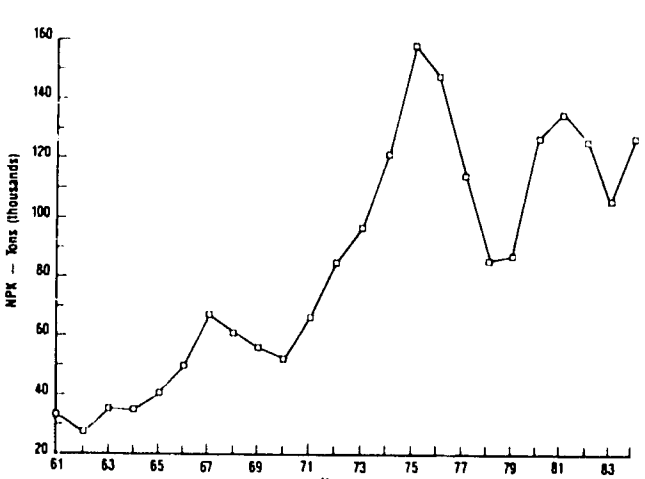


Figure 3. **Fertilizer Consumption – Sudano-Sahel Region.**

West Africa

The Humid and Subhumid West Africa Region consists of Benin, Côte d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Nigeria, Sierra Leone, and Togo. It has about 30% share in the sub-Saharan fertilizer consumption. This is one region in Africa that showed sustained rapid growth in fertilizer consumption at a rate of 15.6% per year during the 1961-84 period (Figure 4).

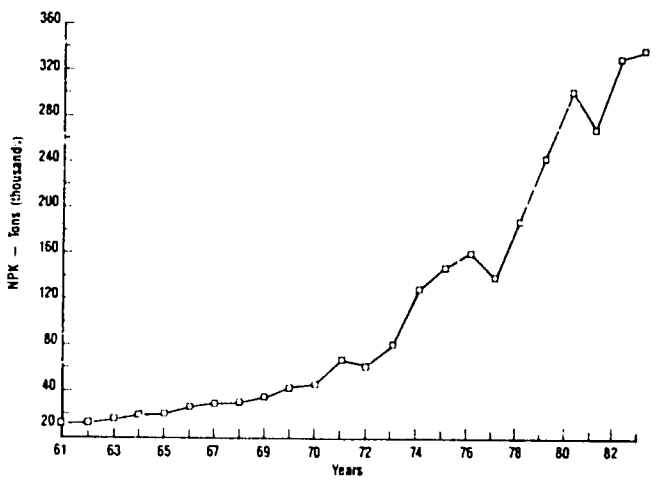


Figure 4. **Fertilizer Consumption – West Africa.**

Starting with an average of 25 thousand tonnes in the 1960s, among the lowest of the five regions, the consumption had grown to over 300 thousand tonnes by the early 1980s and was the highest of all regions by 1984. West Africa is also the only region that showed an acceleration in the growth rate in the 1970s from 15.2% in the 1960s to 17.1% in the 1970s. But the rate fell to 7.4% in the early 1980s. This may be a result of the debt crisis, given that the top two countries in this region, Nigeria and Côte d'Ivoire, are classified by the International Monetary Fund as heavily indebted countries and also that they were highly dependent on imports for fertilizer supplies during the period covered here.

Fertilizer consumption in this region is dominated by Nigeria, Côte d'Ivoire, and Ghana. The major determinants of the growth in fertilizer consumption appear to be oil revenues (in Nigeria) and their utilization for import of fertilizers as well as promotion of fertilizer use; the world price prospects for major export crops (cocoa and coffee, particularly for Côte d'Ivoire and Ghana), and the government policies towards these export crops. It seems that the narrower the crop base of fertilizer use (Ghana/Côte d'Ivoire versus Nigeria), the greater the variability and the lower the prospect of sustained growth in consumption.

Central Africa

The Humid Central Africa Region consists of Cameroon, Central African Republic, Congo, Equatorial

Guinea, Gabon, and Zaire. This region has the lowest total fertilizer consumption of the five regions, only 5% share of sub-Saharan Africa. Consumption grew at 9% per year from 1961 to 1984. It grew rapidly in the 1960s at a rate of 22%, but the growth stalled in the 1970s except for an increase in 1976-77, giving an average rate of only 4% (Figure 5). Consumption accelerated again to 9% in the early 1980s, making this the only region to show an acceleration in the 1980s.

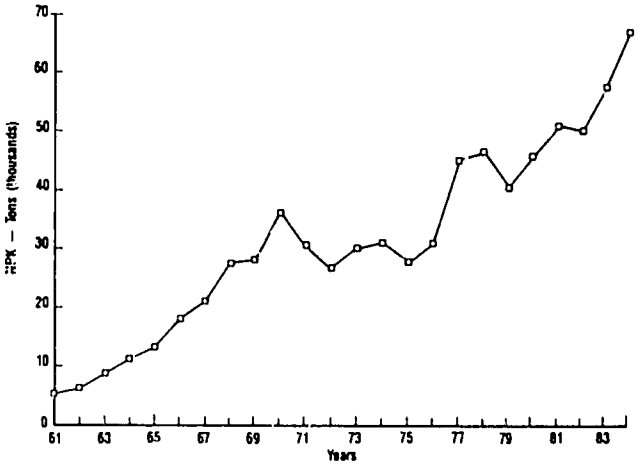


Figure 5. **Fertilizer Consumption – Central Africa.**

The consumption increased from an average of 18,000 tonnes in the 1960s to 55,000 tonnes in the early 1980s. All countries in this region are highly import dependent.

The fertilizer consumption in the region is dominated by Cameroon, Zaire, and Gabon. A detailed study of these countries reveals that in the Central Region earnings from petroleum and mineral wealth seem to have played a major role in fostering growth in fertilizer use, coupled with a need to be less dependent on food imports. Where export crops are important, as in Cameroon, earnings from them have also influenced fertilizer consumption.

East Africa

The Subhumid and Mountain East Africa Region consists of Burundi, Ethiopia, Kenya, Madagascar, Mauritius, Rwanda, and Uganda. The region has a share of 16% in sub-Saharan fertilizer consumption (1980-84).

The 1960s saw a fairly rapid growth at a significant rate of 10.3% per year. However, for most of the 1970s, there was complete stagnation at a level of about 110,000 tonnes. The consumption accelerated during 1979-81, but subsequently shows large fluctuations (Figure 6). Except for Mauritius and Uganda, the region is highly dependent on imports for fertilizer.

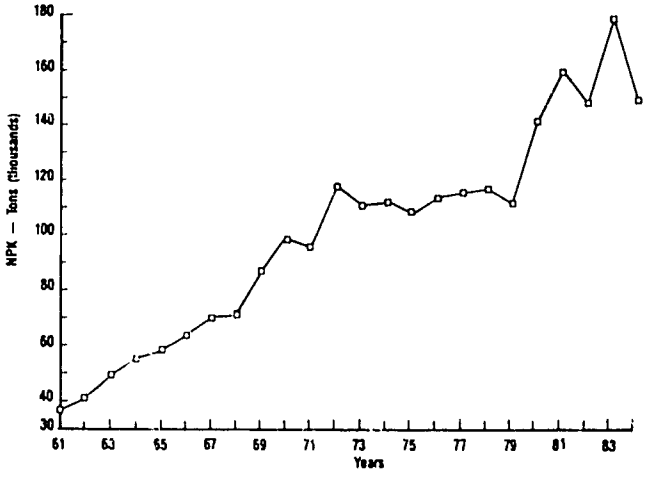


Figure 6. **Fertilizer Consumption – East Africa.**

Fertilizer consumption in this region is dominated by Kenya, Ethiopia, and Mauritius. A detailed study of these countries reveals that fluctuations and growth in the Eastern Region are associated with a variety of factors: the spread of hybrid maize, increase in coffee area, and fertilizer imports and policies towards all of them – as in Kenya. Such policies are associated with stability of use on state farms in Ethiopia and on sugarcane farms in Mauritius.

Southern Africa

The Subhumid and Semiarid Southern Africa Region consists of Angola, Botswana, Malawi, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe. The region has a 36% share of fertilizer consumption in sub-Saharan Africa (1980-84), the largest share of all the regions. The consumption has grown at a rate of 7.4% per year (1961-84). The consumption of this region was significantly higher than that of other regions, but by 1984, it had been surpassed by the rapidly growing consumption in the Western Region.

Consumption grew rapidly in the late 1960s (up to 1971) at a rate of 11% (Figure 7). But during most of the 1970s, there was virtually no growth in consumption, and it hovered around 220,000-230,000 tonnes. In 1979-81 there was a sharp increase, but this was followed by a continuous decline up to 1984. Among all sub-Saharan regions, this one has a relatively more even distribution of fertilizer consumption. Southern Africa is not highly dependent on imports.

The consumption in this region is dominated by Zimbabwe, Zambia, and Malawi. A detailed study of these countries shows that in the Southern Region maize (probably through introduction of hybrid maize) and the export crop of tobacco appear to have played a major role

in fertilizer consumption. At least the initial momentum of growth in consumption appears to have come through larger commercial farms. Subsequently this seems to have reached the smallholders.

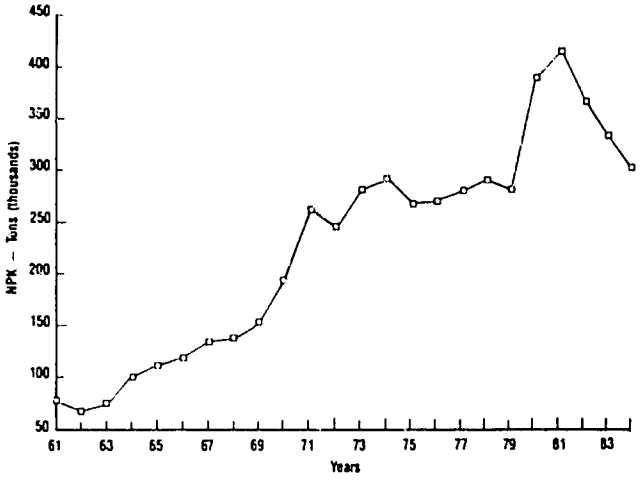


Figure 7. **Fertilizer Consumption – Southern Africa.**

Growth has stalled in the region mainly because of political disturbances and transportation difficulties in Zimbabwe, deteriorating terms of trade leading to debt crisis in most countries, and periodic droughts.

From this brief review of regional trends, again it appears that growth in fertilizer consumption has been a complicated process influenced by a variety of forces. Major forces have been oil revenues when used at least in part towards agricultural development, terms of trade for export crops and other exports, oil/fertilizer import prices, expansion of the crop base of fertilizer use, especially into food crops, spread of hybrid maize, existence of commercial farming, political disturbances, and droughts. In generating faster growth, factors on both the demand and the supply side have been important. And on both sides, government commitment and policies seem to have exerted a strong influence.

Emerging Conclusions

1. Analysis in this study indicates that the FAO data on fertilizer consumption, with all their limitations, are quite dependable for deciphering the major features of sub-Saharan fertilizer consumption. Thus, for instance, the time series of consumption has a large amount of variation, most of which can be traced to important events in the political, economic, or agricultural histories of the countries. The dependability of the data may be due to the fact that much of the fertilizer consumed is imported, and imports are subject to better recordkeeping. The usefulness of the data for sophisticated econometric work on marginal year-to-year changes in consumption, however, may be limited because the data could be reflecting changes in imports rather than in actual consumption.

2. Over the last two decades, fertilizer consumption has increased in all agroecological regions, although at varied rates and with varying degrees of steadiness. This has reduced the skewness in levels of consumption among different regions and also among countries. Notwithstanding this, it is clear that only West Africa had a sustained growth in fertilizer consumption in sub-Saharan Africa. Although oil revenue must have helped this region to maintain growth in imports, it appears that this would not have sufficed without government effort to enhance agricultural development, which broadened the cropwise base of fertilizer use.

3. Countries that depended heavily on export and non-food crops seem to have used the bulk of their fertilizer on these crops. On the whole, their fertilizer consumption growth has been poor. The high variability in the world prices of these agricultural exports (and also the long-term downward trend) has caused large fluctuations in the fertilizer consumption. This must have come from both the fertilizer demand side (in that use is concentrated on such crops) and from the fertilizer supply side (due to import restrictions).

4. It is in the countries where fertilizer use is heavily concentrated on export and non-food crops that the government output pricing policies seem to have played the greatest havoc with respect to growth in fertilizer consumption. These policies are usually tied to the world market conditions and the need to generate both foreign exchange earnings and government revenue. From the viewpoint of growth in fertilizer consumption, concerted efforts are needed to broaden the base of fertilizer use.

5. Countries that have the highest average fertilizer use levels (Zimbabwe and Kenya – ignoring the sugarcane economies of Mauritius and Swaziland) and the most impressive growth performance (Nigeria) seem to have succeeded because of their efforts to push use on food crops, which accounts for high proportions of the cropland.

6. Maize appears to have considerable potential for increasing fertilizer use in sub-Saharan Africa. This probably stems from its wide agroclimatic suitability and relatively high fertilizer response ratio. However, given the low average fertilizer use levels, it is likely that fertilizer use even on this crop is not very common

in many countries. This could be due to deficiencies in both the agricultural research and extension systems as well as inadequate development of the fertilizer distribution system. But their relative importance may be different at different locations. Sharply focused research is necessary to determine which of the two is the more severe constraint.

7. Government commitment to agriculture seems vital for enhancing fertilizer use. In specific terms, greater attention must be given to agricultural research (particularly on food crops) and the development of the physical and institutional infrastructures. The former would accelerate the growth of conversion of the potential into farmers' effective demand for fertilizer by improving the profitability, and the latter is needed to channel supplies to satisfy this demand. Growth in actual consumption cannot occur unless both these processes are operating vigorously.

8. Debt burden seems to have been a major factor in slowing the growth of fertilizer consumption in the early 1980s. Whereas resolution of the debt problem is important, it is equally important to note that in most of the sub-Saharan countries, fertilizer import is only a small fraction of the total import bill. Therefore, curtailing fertilizer imports does not solve the debt problem; in fact it may aggravate it by slowing growth in food production and thus increasing dependence on food imports.

9. Finally, it is clear that despite low levels of fertilizer use the sub-Saharan fertilizer scene has not been stagnant or unchanging. It offers ample opportunities to ask pertinent questions and thus to understand what is required for accelerated growth in fertilizer consumption. The first step in this direction is to ask if past growth in consumption could have been faster. What is lacking in the forces governing fertilizer consumption can be meaningfully identified by asking this pertinent question. But to answer this question, it is imperative to first gather adequate information on the fertilizer scene itself. Without this information, one could be producing "precise" answers to questions that have little bearing on the sub-Saharan fertilizer scene.

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Appendix: Data Notes and Data Sources

1. Regional Classification: Based on Atlas of African Agriculture, FAO (1986).

2. Fertilizer Consumption, Production and Import Data: FAO Fertilizer Tapes and Fertilizer Yearbooks, FAO, various issues.

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6. GNP Per Capita, 1982: Atlas of African Agriculture, FAO (1986).

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22. Debt Per hectare, 1983: Atlas of African Agriculture, FAO (1986).

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24. Identification of Countries with Fertilizer Subsidies: McIntire (1985).

Une Analyse de l'Approvisionnement en Engrais en Afrique Sub-Saharienne

Balu L. Bumb

Résumé

L'utilisation des engrais en Afrique sub-saharienne est limitée. Elle varie énormément d'année en année et de pays en pays. Bien que divers facteurs économiques, techniques, écologiques, institutionnels, et politiques concourent à cette situation, cet exposé se base sur les tendances qui régissent la production et l'importation d'engrais pour déterminer si les fluctuations observées dans la consommation de cet intrant sont liées à l'instabilité des sources d'approvisionnement.

Entre 1962 et 1986, l'utilisation des engrais a connu une rapide augmentation, mais la production n'a pas suivi. Par conséquent, le fossé entre l'offre et la demande s'est élargi au cours de cette période , entraînant un accroissement des importations qui sont passées de 146 000 tonnes d'éléments nutritifs en 1962, à 1 114 000 tonnes en 1986, et fournissent plus de 90 pour cent des engrais utilisés en 1986. Selon les prévisions, cet écart s'accentuera dans les années quatre-vingt-dix, puisque l'augmentation de la production attendue reste faible.

La dépendance excessive de l'Afrique sub-saharienne vis-à-vis des importations introduit trois sortes d'incertitudes qui freinent l'approvisionnement en engrais: la première résulte des fluctuations des prix mondiaux des engrais; la seconde concerne les fluctuations dans les allocations de devises; et la troisième est liée à l'instabilité politique et à la faiblesse de l'engagement de l'Etat.

De plus, les importations sont très coteuses à cause de l'étroitesse des marchés intérieurs. En effet, l'inefficacité des infrastructures physiques et institutionnelles et la position enclavée de certains pays relèvent encore davantage les cots d'importation. Par conséquent, une amélioration de ces infrastructures et du système d'approvisionnement et un développement de la production locale dans des régions viables, contribueraient à promouvoir et à stabiliser l'utilisation des engrais.

Fertilizer Supply in Sub-Saharan Africa – An Analysis

Balu L. Bumb

Introduction

Fertilizer use in sub-Saharan Africa (SSA) is low and variable. It is low because per hectare fertilizer use is only about 9.0 kg; compared with 58.3 kg in the developing countries and 121.3 kg in the developed countries; it is variable because cross-section (intercountry) and time-series fluctuations are large. For example, fertilizer use fluctuated between -10.8% and 34.3% during the 1980s and between -6.1% and 18.4% during the 1970s (see Figure 1 and Table 1). Likewise, per hectare fertilizer use varied between 1.0 kg in Zaire and 56.5 kg in Zimbabwe in 1984-85.

Several economic, political, technical, and institutional factors could be responsible for the low levels and variable nature of fertilizer use in sub-Saharan Africa, and

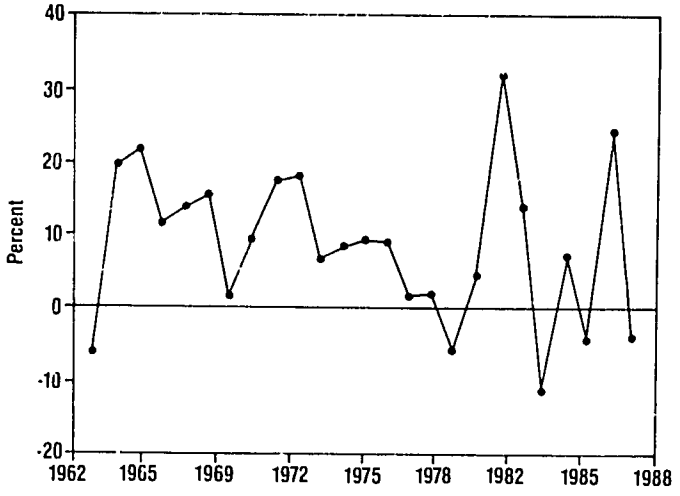


Figure 1. **Sub-Saharan Africa: Total NPK Consumption Annual Percentage Change 1962-87.**

Table 1. **Sub-Saharan Africa: Fertilizer Consumption** (tonnes)[a]

	Nitrogen	Change (%)	Phosphate	Change (%)	Potash	Change (%)	Total	Change (%)
1962	80,555		47,042		34,430		162,027	
1963	73,655	-8.566	42,124	-10.454	35,905	4.284	151,684	-6.384
1964	88,655	20.365	45,104	7.074	48,276	34.455	182,035	20.009
1965	117,293	32.303	49,434	9.600	55,042	14.015	221,769	21.828
1966	131,321	11.960	59,447	20.255	53,893	-2.087	244,661	10.322
1967	146,757	11.754	68,719	15.597	62,098	15.255	277,574	13.452
1968	171,431	16.813	88,237	28.403	63,332	1.987	323,000	16.365
1969	176,031	2.683	88,031	-0.233	63,505	0.273	327,567	1.414
1970	188,396	7.024	97,700	10.984	74,155	16.770	360,251	9.978
1971	222,553	18.130	114,937	17.643	88,949	19.950	426,439	18.373
1972	273,167	22.742	127,059	10.547	104,967	18.008	505,193	18.468
1973	281,113	2.909	142,969	12.522	117,415	11.859	541,497	7.186
1974	296,966	5.639	165,054	15.447	122,220	4.092	584,240	7.893
1975	317,720	6.989	178,415	8.095	145,543	19.083	641,678	9.831
1976	381,487	20.070	187,315	4.988	129,056	-11.328	697,858	8.755
1977	372,032	-2.478	208,216	11.158	128,696	-0.279	708,944	1.589
1978	341,786	-8.130	217,173	4.302	157,674	22.517	716,633	1.085
1979	328,122	-3.998	194,772	-10.315	149,949	-4.899	672,843	-6.111
1980	376,811	14.839	192,692	-1.068	136,921	-8.688	706,424	4.991
1981	528,888	40.359	257,030	33.389	162,506	18.686	948,424	34.257
1982	556,656	5.250	325,190	26.518	187,958	15.662	1,069,804	12.798
1983	502,422	-9.743	270,358	-16.862	181,530	-3.420	954,310	-10.796
1984	497,502	-0.979	326,525	20.775	188,345	3.754	1,012,372	6.084
1985	496,291	-0.243	303,245	-7.130	178,891	-5.020	978,427	-3.33
1986	644,959	29.956	355,725	17.306	211,376	18.159	1,212,060	23.878
1987	644,200	-0.118	343,700	-3.380	176,500	-16.500	1,164,400	-3.932

a. All fertilizer quantities except prices in this paper are nutrient metric tons, unless indicated otherwise.
Source: FAO Fertilizer Yearbooks.

therefore further research is required to identify the proper role of these factors. However, this paper focuses on the trends in fertilizer production and imports to see whether the fluctuations in fertilizer use originated from the fluctuations in supply sources. This approach is used for two reasons. First, fertilizer imports account for more than 90% of fertilizer use in sub-Saharan Africa; second, a statistical analysis of the FAO data on fertilizer consumption and imports revealed that during the 1980-87 period the reported fertilizer consumption was identical to fertilizer imports for 24 to 28 of the 40 countries in sub-Saharan Africa (Table 2). Hence, for many countries the fluctuations in fertilizer use could be reflections of the fluctuations in fertilizer imports.

Table 2. **Total NPK[a] Consumption Versus Imports in Sub-Saharan Africa**

Year	(1) Consumption < Imports	(2) Consumption = Imports	(3) Consumption > Imports
	(Number of Countries Out of Total 40 SSA Countries)		
1980	5	26	9
1981	8	24	8
1982	3	24	13
1983	4	27	9
1984	5	26	9
1985	9	24	7
1986	6	26	8
1987	2	28	10

a. Total NPK means N + P_2O_5 + K_2O.
Source: Derived from FAO data.

In addition to analyzing the trends in production and imports, the paper also analyzes the pricing environment to identify the role of crop and fertilizer prices in producing low and fluctuating levels of fertilizer use in sub-Saharan Africa.

The rest of the paper is divided into three sections. The next section deals with the trends in fertilizer supplies through production and imports; it also discusses the supply/demand balances to the year 2000. The following section analyzes the pricing environment; it covers import and distribution costs of fertilizer products as well as farm-level crop and fertilizer prices. The last section summarizes the main findings of the paper and identifies issues for further research.

Fertilizer Supply in Sub-Saharan Africa

Trends in fertilizer production and imports are analyzed to identify fluctuations in fertilizer supply and their impact on fertilizer use. Overall, because of the small production base, fertilizer supply in sub-Saharan Africa is largely dependent on fertilizer imports. For example, in 1985-86, imports accounted for more than 90% of fertilizer use in sub-Saharan Africa, and 30 of the 40 countries relied exclusively on fertilizer imports. Such a heavy dependence on fertilizer imports may make sub-Saharan Africa's fertilizer use fluctuate with fluctuations in imports.

Production

Table 3 provides data on total and nutrientwise fertilizer production in sub-Saharan Africa. It is clear from the table that total fertilizer production has shown very little growth during the 1980s. It increased from 178,000 tonnes in 1980 to 203,000 tonnes in 1982 and to 212,000 tonnes in 1986,[1] with year-to-year fluctuations in between, and averaged around 192,000 tonnes of nutrients. Against the fluctuating level of production in the 1980s, the total fertilizer production increased from 137,000 tonnes in 1970 to 471,000 tonnes in 1975, and then dropped to 240,000 tonnes in 1979. The main reason for this rapid rise and fall in production in the 1970s was the opening of a potash mine in Congo in 1970 and its closure due to flooding in 1978. Consequently, the fluctuations in total fertilizer production after 1978 are ascribable to fluctuations in nitrogen and phosphate production.

During the 1970s, nitrogen production increased nearly fourfold, from 25,000 tonnes in 1970 to 99,000 in 1980. There was another 10%-12% growth in nitrogen production during the 1980s. Nitrogen production fluctuated between 96,000 and 115,000 tonnes between 1980 and 1988. The changes in capacity utilization seem to have produced these fluctations because there was little growth in the installed capacity.

Like nitrogen production, phosphate production also increased rapidly during the 1970s but then fluctuated around 85,000 tonnes between 1980 and 1985. Whether the observed 20% increase in production in 1986 over 1985 is due to improved capacity utilization or due to an increase in installed capacity is not clear, for Senegal's new phosphoric acid plant with a capacity of 230,000 tonnes was commissioned in 1984-85. However, the levels of phosphate production in 1986 and 1987 were not significantly different from those in 1974 and 1975. Thus, after the mid-1970s, sub-Saharan Africa did not see any increase in phosphate production. Likewise, there was very little growth in nitrogen production between the mid-1970s and the mid-1980s. Because of little growth in nitrogen and phosphate production, there was little change in total production during the 1980s (Figure 2).

1. All the years referred to or used in this paper are split years and are usually indicated by the latter half of the split year; for example, 1986 refers to 1985-86.

Table 3. **Sub-Saharan Africa: Fertilizer Production** (tonnes)

	Nitrogen	Change (%)	Phosphate	Change (%)	Potash	Change (%)	Total	Change (%)
1962	0		11,600		0		11,600	
1963	0		12,420	7.069	0		12,420	7.069
1964	0		16,976	36.683	0		16,976	36.683
1965	0		19,100	12.512	0		19,100	12.512
1966	0		25,600	34.031	0		25,600	34.031
1967	0		25,202	-1.555	0		25,202	-1.555
1968	1,004		34,586	37.235	0		35,590	41.219
1969	2,530	151.992	38,292	10.715	0		40,822	14.701
1970	24,806	830.474	45,165	17.949	67,000		136,971	235.532
1971	48,881	97.053	55,825	23.602	123,000	83.582	227,706	66.244
1972	80,973	65.653	63,530	13.892	257,820	109.610	402,373	76.707
1973	90,541	11.816	82,952	30.469	284,280	10.263	457,773	13.768
1974	87,777	-3.053	93,540	12.764	265,440	-6.627	446,757	-2.406
1975	91,335	4.053	94,810	1.358	285,060	7.392	471,205	5.472
1976	94,409	3.366	83,650	-11.771	277,140	-2.778	455,199	-3.397
1977	96,128	1.821	81,896	-2.097	266,800	-3.731	444,824	-2.279
1978	88,441	-7.997	69,808	-14.760	81,300	-69.528	239,549	-46.147
1979	92,944	5.092	78,700	12.738	0	-100.000	171,644	-28.347
1980	98,900	6.408	79,000	0.381	0		177,900	3.645
1981	114,617	15.892	84,500	6.962	0		199,117	11.926
1982	112,790	-1.594	90,150	6.686	0		202,940	1.920
1983	113,305	0.457	65,948	-26.846	0		179,253	-11.672
1984	103,598	-8.567	85,006	28.899	0		188,604	5.217
1985	96,921	-6.445	81,800	-3.771	0		178,721	-5.240
1986	112,154	15.717	100,500	22.861	0		212,654	18.987
1987	96,100	-14.314	101,800	1.294	0		197,900	-6.938

Source: FAO Fertilizer Yearbooks.

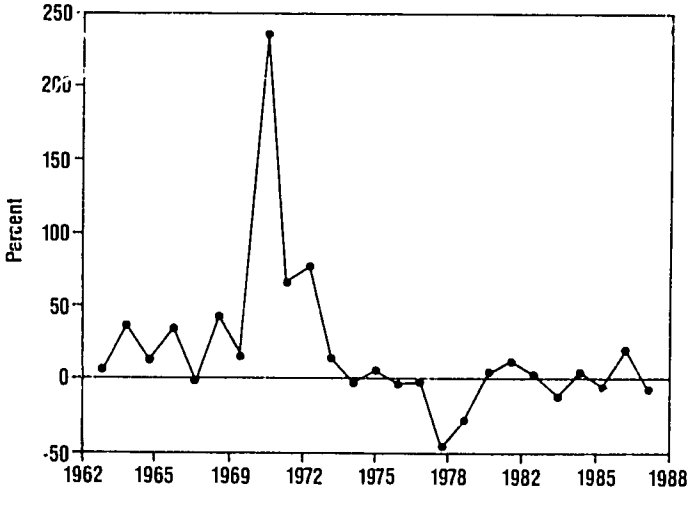


Figure 2. **Sub-Saharan Africa: Total NPK Production Annual Percent Change 1962-87.**

Regional Concentration of Production

Not only was growth in fertilizer production slight in sub-Saharan Africa, it was also concentrated in only a few countries. Thirty of the forty countries do not produce any fertilizers. Of the ten countries that were producing fertilizers in the mid-1980s, two countries, namely, Zimbabwe and Senegal, accounted for about 80% of the total fertilizer production. Another 10% was contributed by Tanzania and Mauritius (Table 4). Thus, about 90% of the total fertilizer production was concentrated in these four countries: one each in west and south Africa, and two in east Africa.[2]

Although Nigeria's contribution to the total fertilizer production in sub-Saharan Africa was small (2.5%) in the mid-1980s, large-scale ammonia and urea plants were commissioned in 1987, and thus the country's share in total production will increase significantly by 1989-90 and thereafter.

The Widening Gap Between Consumption and Production

Because there was very little growth in indigenous production, the gap between consumption and production

2. Reference here is only to sub-Saharan Africa.

Table 4. **Countrywise Fertilizer Production in Sub-Saharan Africa: N, P_2O_5, and Total NP**

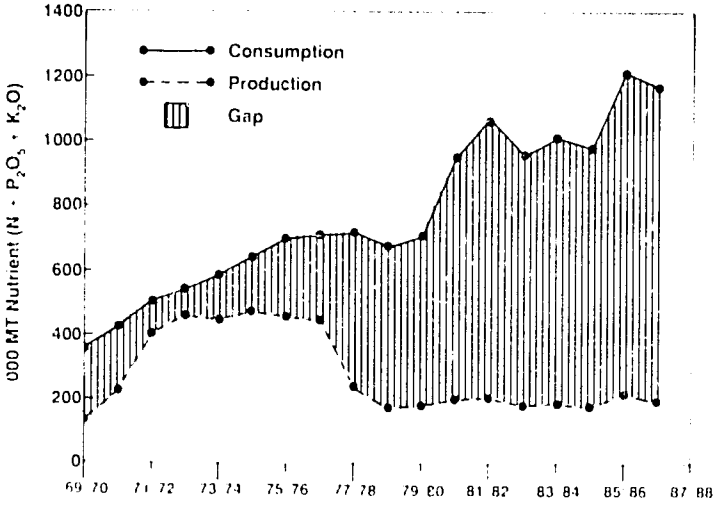
Country	1983/84	1984/85	1985/86	Average 1984/86	Share
	(tonnes)				(%)
Nitrogen					
Côte d'Ivoire	3,900	1,000	2,600	2,500.00	2.40
Mauritius	9,037	7,796	9,208	8,680.33	8.33
Mozambique	500	0	0	166.67	0.16
Senegal	3,500	10,000	12,000	8,500.00	8.16
Somalia	0	2,000	9,200	3,733.33	3.58
Swaziland	5,000	0	0	1,666.67	1.60
Tanzania	4,966	2,500	7,000	4,822.00	4.63
Zambia	5,695	5,025	2,446	4,388.67	4.21
Zimbabwe	71,000	68,600	69,700	69,766.67	66.94
N Total	**103,598**	**96,921**	**112,154**	**104,224.33**	**100.00**
Phosphate					
Côte d'Ivoire	2,000	3,100	2,600	2,566.67	2.88
Mozambique	200	0	0	66.67	0.07
Nigeria	4,200	5,000	5,000	4,733.33	5.31
Senegal	30,000	30,000	37,500	32,500.00	36.48
Tanzania	4,106	4,000	7,100	5,068.67	5.69
Zimbabwe	44,500	39,700	48,300	44,166.67	49.57
P_2O_5 Total	**85,006**	**81,800**	**100,500**	**89,102.00**	**100.00**
N + P_2O_5					
Côte d'Ivoire	5,900	4,100	5,200	5,066.67	2.[illegible]
Mauritius	9,037	7,796	9,208	8,680.33	4.49
Mozambique	700	0	0	233.33	0.12
Nigeria	4,200	5,000	5,000	4,733.33	2.45
Senegal	33,500	40,000	49,500	41,000.00	21.21
Somalia	0	2,000	9,200	3,733.33	1.93
Swaziland	5,000	0	0	1,666.67	0.86
Tanzania	9,072	6,500	14,100	9,890.67	5.12
Zambia	5,695	5,025	2,446	4,388.67	2.27
Zimbabwe	115,500	108,300	118,000	113,933.33	58.93
NP Total	**188,604**	**178,721**	**212,654**	**193,326.33**	**100.00**

Source: FAO Fertilizer Yearbooks.

widened over time (Figure 3) and made sub-Saharan Africa increasingly dependent on fertilizer imports. In absolute terms, this gap widened from 139,000 nutrient tonnes in 1970 to 1,014,000 nutrient tonnes in 1986. Thus, in 1986, about 94% of the total fertilizer requirements were met by imports. The consequences of this widening gap between consumption and production and the resulting import dependence are analyzed below.

Future Outlook

The current gap between consumption and production is not only large but also expected to remain so, and it could become even larger in the future unless decisions are made and implemented to promote economically viable and socially desirable production facilities in sub-Saharan Africa.



Source: FAO

Note: Does not include ground phosphate rock for direct application

Figure 3. **Sub-Saharan Africa: Gap Between Total Fertilizer Consumption and Production.**

Supply/demand balances for nitrogen, phosphate, potash, and total nutrients in sub-Saharan Africa are indicated in Table 5 and Figure 4. Two sets of demand projections are used: one set from the FAO/UNIDO/World Bank Working Group (WG) and the other from FAO. Because no separate demand forecasts are prepared by the Working Group for sub-Saharan Africa, its projected nutrientwise growth rates for the developing market economies of Africa are used to derive nutrientwise demand forecasts for sub-Saharan Africa. Furthermore, because the Working Group's forecasts are available only for the period 1986-92, the demand forecasts for the 1993-2000 period are derived by using the projected growth rates for the 1986-92 period. FAO's demand forecasts are available for the 1984-2000 period, but these are not available nutrientwise.

The major difference between the Working Group's demand forecasts and FAO's forecasts is that the former refer to effective demand, whereas the latter are normative fertilizer requirements to achieve a reasonable degree of food security. Another difference between the two is the difference between the projected growth rates. FAO's projections imply an annual growth of 6.4%, and the Working Group's projections imply an annual growth of 3.6%. Thus, according to these estimates, fertilizer use in sub-Saharan Africa could grow from 1.2 million nutrient tonnes in 1985-86 to anywhere between 2.1 (WG) and 2.9 (FAO) million tonnes in the year 2000. Of the 2.1 million

tonnes of total fertilizer demand projected by the Working Group, 1.1 million tonnes is for nitrogen, 0.6 million tonnes for phosphate, and 0.4 million tonnes for potash.

Table 5. **Sub-Saharan Africa: Supply/Demand Balances, 1985-2000**

	1985/86 (Actual)	1990	1995	2000
	('000 tonnes)			
A. Demand Projections				
A.1 Working Group				
N	645	743	887	1,058
P2O5	356	418	511	625
K2O	211	255	322	407
Total	1,212	1,416	1,720	2,090
A.2 FAO				
Total	1,212	1,540	2,100	2,860
B. Supply Potential: Working Group Projections				
N	100	420	420	420
P2O5	266	285	285	285
Total	366	705	705	705
C. GAP (Demand-Supply)				
C.1 Based on the Working Group Demand Projections				
N	545	323	467	638
P2O5	90	133	226	340
K2O	211	255	322	407
Total	846	711	1,015	1,385
C.2 Based on the FAO Demand Projections				
Total	846	835	1,395	2,155

Source: The FAO/UNIDO/World Bank Working Group, Annual Meeting, 1986; and FAO: *Agriculture: Toward 2000* (1987).

Compared with 3.6% to 6.4% projected annual growth in demand, the projections of supply potential prepared by the Working Group indicate that there will be little growth in supply potential after 1990 although supply potential is expected to double between 1986 and 1990, mostly because of Nigeria's recently commissioned ammonia-urea and NPK plants. Hence, with growing demand and unchanged levels of supply potential, the gap between demand and supply will grow large during the 1990s It could increase from 0.7-0.8 million tonnes of nutrients in 1990 to 1.4-2.2 million tonnes of nutrients in 2000.

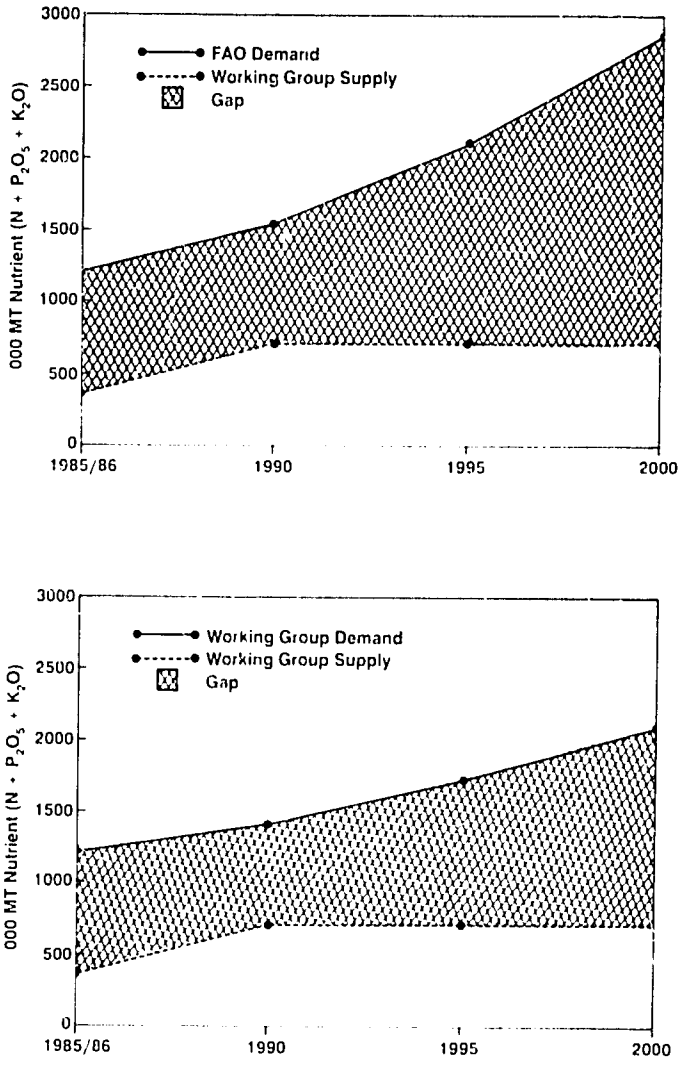


Figure 4. **Sub-Saharan Africa: Gap Between Total NPK Demand and Potential Supply.**

Whether sub-Saharan Africa should depend on imported fertilizers to fill this gap or invest in building viable productive capacities is an area which requires further research. Furthermore, the concentration of most of the existing capacity in West Africa (Nigeria and Senegal) raises another question: What optimum solutions can be devised to disperse further capacity in different regions of sub-Saharan Africa to use domestic resources and available technologies in an economically viable manner?

Imports

The concentration of fertilizer production in a few countries, along with the very small production base, makes sub-Saharan Africa's fertilizer use highly dependent on imports. In 1985/86, more than 90% of the chemical fertilizers used were imported. The range of import dependence varied from 27% in Zimbabwe to 100% in

Table 6. **Ratio of Fertilizer Imports to Consumption in Sub-Saharan Africa, 1984-86 Average**

	Country	Average Consumption	Average Imports	Ratio
		------ (tonnes)	------	(%)
1	Angola	11,978	12,311	102.780
2	Benin	8,067	8,067	100.000
3	Botswana	1,033	1,033	100.000
4	Burkina Faso	12,168	12,195	100.222
5	Burundi	2,292	2,359	102.923
6	Cameroon	49,833	53,167	106.689
7	Central African Republic	1,518	1,518	100.000
8	Chad	6,633	6,633	100.000
9	Congo	3,067	3,067	100.000
10	Côte d'Ivoire	40,233	57,831	143.740
11	Ethiopia	49,029	58,351	119.012
12	Gabon	2,600	2,600	100.000
13	Gambia	2,800	3,333	119.036
14	Ghana	14,100	14,267	101.184
15	Guinea Bissau	167	167	100.000
16	Guinea	183	183	100.000
17	Kenya	88,481	88,481	100.000
18	Lesotho	4,200	4,200	100.000
19	Liberia	2,533	2,533	100.000
20	Madagascar	10,100	10,100	100.000
21	Malawi	40,592	43,434	107.001
22	Mali	21,600	21,600	100.000
23	Mauritania	997	997	100.000
24	Mauritius	27,398	21,529	78.579
25	Mozambique	7,464	9,482	127.036
26	Niger	2,502	2,502	100.000
27	Nigeria	285,600	318,933	111.671
28	Rwanda	1,233	1,233	100.000
29	Senegal	21,800	17,333	79.509
30	Seychelles	133	133	100.000
31	Sierra Leone	2,030	2,030	100.000
32	Somalia	3,360	1,620	48.214
33	Sudan	58,320	62,920	107.888
34	Swaziland	11,333	9,667	85.299
35	Tanzania	31,745	22,713	71.548
36	Togo	6,587	6,987	106.073
37	Uganda	233	233	100.000
38	Zaire	9,144	9,144	100.000
39	Zambia	67,500	30,876	45.742
40	Zimbabwe	157,033	42,467	27.043

Source : Derived from FAO data.

Kenya, Malawi, Cameroon, Burkina Faso, and several others (Table 6).

Unlike fertilizer production, which showed little growth between the mid-1970s and the mid-1980s, total fertilizer imports in sub-Saharan Africa grew rapidly from 316,000 tonnes in 1970 to 1,146,000 tonnes in 1986–at a compound rate of 8.0% per annum. Fertilizer imports of individual nutrients also increased uniformly: nitrogen imports by 7.8%, phosphate by 8.9%, and potash by 7.6%. Despite this rapid growth, the annual fluctuations in the total as well as nutrientwise fertilizer imports were wide. For example, the annual percentage changes varied between -9.9 and 16.3 during the 1970s and between -20.2 and 30.2 during the 1980s (Figure 5 and Table 7). Likewise, the imports of individual nutrients show wider fluctuations; nitrogen imports decreased in 1974, 1978, 1983, 1984, and 1987; phosphate imports fell in 1974, 1976, 1979, 1983, 1985, and 1987; and potash imports fell in 1980, 1983, 1985, and 1987 (Figure 6).

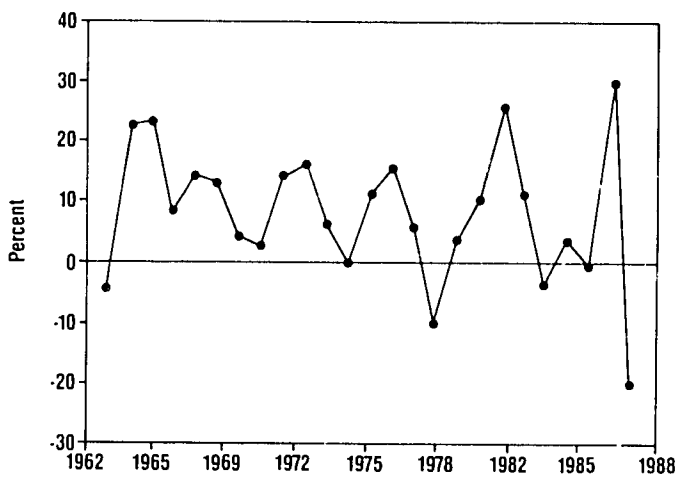


Figure 5. **Sub-Saharan Africa: Total NPK Imports Annual Percent Change 1962-87.**

What are the factors responsible for such fluctuations in fertilizer imports in sub-Saharan Africa? Are these fluctuations caused by the changes in world prices, by foreign exchange shortages, by poor marketing systems, by droughts, or by the lack of commitment on the part of policymakers? Although a country-level analysis of trends in fertilizer imports might throw some light on this, further research is needed. However, the general slowdown in imports in the early 1980s compared with the 1970s would suggest that the foreign exchange shortages and the debt crises must have played a more important role in this deceleration than the world fertilizer prices because fertilizer prices were generally lower in the 1980s than in the 1970s (Table 8). Furthermore, many countries were able to use chemical fertilizers in the mid-1980s simply because these were made available through aid.[3]

To the extent that fertilizer imports are constrained by foreign exchange shortages, fertilizer and other kinds of

3. See FAO Current World Fertilizer Situation and Outlook, 1983/84-1989/90 (1985) for details.

aid can play an important role in relieving this constraint in the short run. However, the long-run solution may be either in improving the production base or in increasing foreign exchange availability or both. More research in this area is needed to clearly identify the sources of fluctuations on a country-by-country basis. Whatever the source or the cause of these fluctuations in fertilizer imports, it is clear that these fluctuations in imports are partly responsible for the fluctuations in fertilizer use we have observed earlier, assuming that all stocks are depleted periodically.

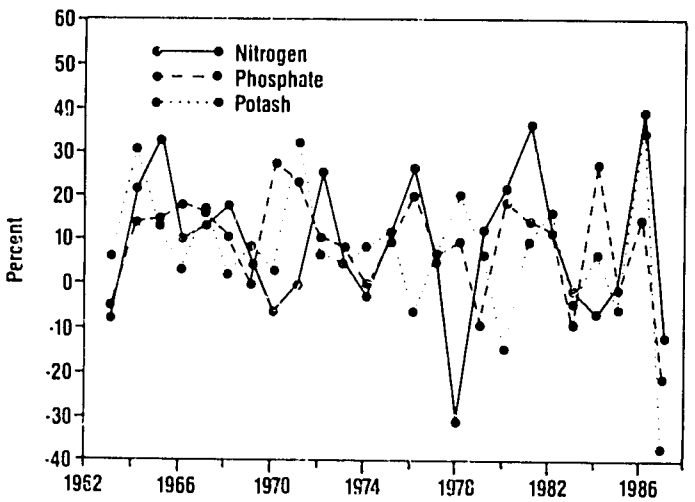


Figure 6. **Sub-Saharan Africa: Nitrogen, Phosphate, and Potash Imports: Annual Percent Change 1962-86.**

Consequences of Import Dependence

Sub-Saharan Africa's heavy dependence on imported fertilizers introduces two uncertainties in fertilizer supply. The first uncertainty results from the volatility of world fertilizer prices (Figure 7). The coefficient of variation[4] of world fertilizer (urea) prices between 1970 and 1986 was 77.5%, indicating wide fluctuations in world fertilizer prices. The second uncertainty results from the annual allocations of foreign exchange to import fertilizers at the country level. There are two components to this uncertainty: one results from changes in the foreign

4. Coefficient of variation is a percentage ratio of standard deviation to arithmetic average.

Table 7. **Sub-Saharan Africa: Fertilizer Imports** (tonnes)

	Nitrogen	Change (%)	Phosphate	Change (%)	Potash	Change (%)	Total	Change (%)
1962	79,662		32,054		34,430		146,146	
1963	72,880	-8.513	30,350	-5.316	36,401	5.725	139,631	-4.458
1964	88,535	21.481	34,506	13.694	48,485	33.197	171,526	22.842
1965	117,639	32.873	39,215	13.647	54,946	13.326	211,800	23.480
1966	128,335	9.092	45,979	17.249	54,690	-0.466	229,004	8.123
1967	145,540	13.406	53,684	16.758	62,501	14.282	261,725	14.288
1968	172,897	18.797	58,909	9.733	64,063	2.499	295,869	13.046
1969	180,307	4.286	58,245	-1.127	70,092	9.411	308,644	4.318
1970	167,639	-7.026	75,014	28.790	73,787	5.272	316,440	2.526
1971	168,505	0.517	92,966	23.932	100,167	35.752	361,638	14.283
1972	210,624	24.996	102,469	10.222	107,380	7.201	420,473	16.269
1973	221,605	5.214	110,917	8.244	113,924	6.094	446,446	6.177
1974	212,604	-4.062	110,656	-0.235	123,020	7.984	446,280	-0.037
1975	236,973	11.462	122,305	10.527	138,119	12.274	497,397	11.454
1976	301,263	27.130	145,232	18.746	128,791	-6.754	575,286	15.659
1977	316,013	4.896	155,664	7.183	136,817	6.232	608,494	5.772
1978	215,034	-31.954	169,908	9.150	163,290	19.349	548,232	-9.903
1979	241,875	12.482	152,520	-10.234	174,412	6.811	568,807	3.753
1980	296,071	22.407	183,174	20.098	148,598	-14.801	627,843	10.379
1981	410,397	38.614	213,539	16.577	166,595	12.111	790,531	25.912
1982	452,605	10.285	235,844	10.445	191,570	14.991	880,019	11.320
1983	447,584	-1.109	216,154	-8.349	184,461	-3.711	848,199	-3.616
1984	413,517	-7.611	273,188	26.386	195,294	5.873	881,999	3.985
1985	419,448	1.434	272,445	-0.272	186,842	-4.328	878,735	-0.370
1986	584,195	39.277	310,224	13.867	249,533	33.553	1,143,952	30.182
1987	513,800	-12.050	245,000	-21.025	153,800	-38.365	912,600	-20.224

Source: FAO Fertilizer Yearbooks.

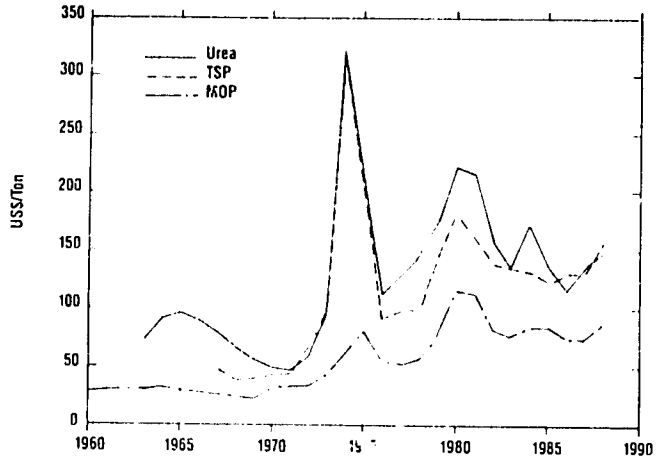
Table 8. **Global Fertilizer Prices, 1960-85**

	Phosphate Rock[a]		Urea[b]		TSP[c]		DAP[d]		Potash[e]	
	Current	1985 Constant[f]	Current	1985 Constant[f]	Current	1985 Constant[f]	Current	1985 Constant[f]	Current	1985 Constant[f]
	(US $/tonne)									
1960	13.0	43.2							28.5	94.7
1961	13.0	42.5							30.0	98.0
1962	11.5	37.0							30.0	96.5
1963	11.5	37.6	72.3	236.3					30.0	98.0
1964	12.5	40.1	90.5	290.1					32.5	104.2
1965	14.0	44.6	95.8	305.1					29.5	93.9
1966	13.0	39.9	89.3	273.9					27.5	84.4
1967	12.0	36.5	79.3	241.0	47.0	142.9	68.5	208.2	25.5	77.5
1968	11.5	35.2	65.5	200.3	38.0	116.2	65.5	200.3	24.0	73.4
1969	11.3	32.9	56.0	163.3	39.0	113.7	58.0	169.1	22.0	64.1
1970	11.0	30.1	48.3	132.3	42.5	116.4	54.0	147.9	31.5	86.3
1971	11.3	29.4	46.0	119.5	43.3	112.5	61.8	160.5	32.5	84.4
1972	11.5	27.4	59.3	141.5	67.5	161.1	91.0	217.2	33.5	80.0
1973	13.8	28.4	94.8	195.1	99.5	204.7	118.8	244.4	42.5	87.4
1974	54.5	92.1	315.8	533.4	303.6	512.8	332.6	561.8	60.5	102.2
1975	67.0	101.8	198.0	300.9	202.5	307.8	243.0	369.3	81.3	123.6
1976	36.0	54.0	112.0	167.9	90.9	136.3	120.0	179.9	55.0	82.5
1977	30.5	41.6	127.4	173.8	97.9	133.6	133.0	181.4	51.0	69.6
1978	29.0	34.4	144.8	171.8	98.0	116.3	139.8	165.8	56.4	66.9
1979	33.0	34.6	172.9	181.0	142.2	148.9	193.3	202.4	76.7	80.3
1980	46.7	44.6	222.1	212.1	180.3	172.2	222.2	212.2	115.7	110.5
1981	49.5	47.1	216.0	205.3	161.3	153.3	195.0	185.4	112.4	106.8
1982	42.4	40.8	158.8	153.0	138.4	133.3	182.8	176.1	81.6	78.6
1983	36.9	36.5	135.4	134.1	134.7	133.4	183.5	181.7	75.3	74.6
1984	38.3	38.6	171.3	172.5	131.3	132.2	189.1	190.4	83.7	84.3
1985	33.9	33.9	136.3	136.3	121.4	121.4	169.0	169.0	84.0	84.0

a. Price of 75% BPL rock, FAS Casablanca through 1975; that of 72% BPL rock in 1976-80; and that of 70% BPL rock from 1981 onward.
b. Bagged, f.o.b. N.W. Europe.
c. Bulk, f.o.b. Florida.
d. Bulk, f.o.b. Florida.
e. Bulk, f.o.b. Vancouver.
f. Deflated by manufacturing unit value (MUV) index.

Sources: British Sulphur Corporation and World Bank (Economic Analysis and Projections Department).

exchange earnings and the other from the governmental commitment to import fertilizers. Because many African countries depend on commodity exports for foreign exchange earnings, they experience wide fluctuations in their export earnings resulting from commodity booms and busts. Even those countries that depended on oil exports were not immune to such fluctuations. Consequently, whenever there is a foreign exchange crisis, fertilizer imports are cut drastically. For example, Nigeria reduced its fertilizer imports significantly in 1983. Further growth in fertilizer imports was facilitated by an IBRD loan from the World Bank. Besides, the governmental commitment could also vary with the change, not uncommon in sub-Saharan Africa, in administrators and policymakers. These two uncertainties result in either excessive imports and surpluses and the associated storage costs and wastes or acute shortages resulting in high prices and low crop output.



Source: World Bank/Green Markets.

Figure 7. **Global Fertilizer Prices, 1960-87.**

Small Size of Market

In addition to the uncertainties mentioned above, sub-Saharan Africa's dependence on imports poses another problem. Because of its low level of demand and because of the division of that low demand among many countries, the quantity imported by each country is very small. For example, during the 1984-86 period, 28 of the 40 countries imported less than 20,000 tonnes of fertilizer nutrients, and 17 of these 28 imported less than 5,000 tonnes of nutrients. Only six countries imported more than 50,000 tonnes and only Nigeria more than 100,000 tonnes. Furthermore, these top six countries accounted for about two-thirds of the total imports (Table 9).

The small size of the fertilizer market at the country level deprives these countries of the benefits of economies of scale that large countries have in importing large quantities. This results in a relatively higher price for African countries and farmers. This increase in price could be anywhere between 20% and 50%. Data in Table 10 indicate that the c.i.f. prices for urea paid by Zambia and Tanzania were 35%-40% higher than those paid by the Philippines. For Zambia, the border price was even higher because of its landlocked position (see Table 11). The cost of transporting urea from the port to the Zambian border was $75/tonne. Thus, compared with the world price (f.o.b. western Europe) of $136/tonne in 1985, Zambia's border price for urea was $330/tonne or 143% higher.

Table 9. **Size Distribution of Fertilizer Imports in Sub-Saharan Africa, 1984-86**

Size ('000 nutrient tonnes)	Number of Countries	Share in Total Import (%)
Less than 5	17	3
5-10	6	5
10-20	5	7
20-50	6	19
50-100	5	33
100+	1	33
Total	40	100

Source: Derived from data available in FAO Fertilizer Yearbooks.

Table 10. **Import Costs: c.i.f. Prices, 1985/86**

Countries	Product	1985 c.i.f. Cost (U.S. $)
Africa		
Tanzania	Urea	240
Zambia	Urea	255[a]
Sudan	Urea	138
Ghana	AS	103
Burkina Faso	15-20-15	318[b]
Rwanda	17-17-17	252[c]
Madagascar	16-16-16	219
Asia		
Malaysia	Urea	128
Philippines	Urea	178
Sri Lanka	Urea	115
Thailand	Urea	170
World	Urea	136[d]

a. c.i.f. Dar es Salaam.
b. Ex-factory Abidjan, Cote d'Ivoire.
c. c.i.f. Mombassa.
d. f.o.b. northwest Europe.

Source: FAO/FIAC: "Fertilizer Marketing Costs and Margins in Developing Countries, 1985-86," (1987).

Hence, further research is needed to determine ways in which the countries of sub-Saharan Africa can reduce their costs of imported materials and their dependence on imports.

Pricing Environment

In this section, we analyze the marketing and distribution costs and the prices paid by farmers at the farm level. The marketing and distribution costs are analyzed to assess the availability of institutional and infrastructural facilities and the influence of these facilities on marketing and distribution costs; the price analysis is geared to analyze the profitability of fertilizer use at the farm level.

Table 11. **Import Costs to the Border in Landlocked Countries, 1985**

Country	Product	c.i.f.	Costs to the Border	Total
		-----	(US $/tonne)	-----
Zambia	Urea	255[a]	75	330
Rwanda	17-17-17	252[b]	173	425
Burkina Faso	15-20-15	318[c]	27	345

a. Dar es Salaam.
b. Mombassa.
c. Ex-factory, Abidjan, Côte d'Ivoire.

Source: FAO/FIAC: "Fertilizer Marketing Costs and Margins in Developing Countries, 1985-86" (1987).

Marketing and Distribution Costs

Although an analysis of marketing and distribution arrangements would shed more light on the adequacy of such arrangements, an analysis of marketing and distribution costs can reflect, to a large degree, the nature and the adequacy of such arrangements. Any country well served by infrastructural and institutional arrangements will generally have lower costs in distributing fertilizers. Data collected by FAO on marketing and distribution costs are presented in Tables 12a and 12b. It is clear from these data that not only do the African countries have to pay higher prices for their imported materials but they also have to incur higher transportation, marketing, and distribution costs because of inadequate infrastructural facilities. In Africa only 5 km of roads is available for every 100 km^2 of area in comparison with 45 km/100 km^2 in Asia.

Table 12a. **Marketing Costs and Margins in Asia and the Pacific, 1985/86**

	India		Indonesia		Malaysia		Philippines		Nepal		Republic of Korea		Sri Lanka		Thailand		China
	Urea	Urea	Urea	TSP	Urea	Urea	Urea	14-14-14	Urea	20-20-0	Urea	21-17-17	Urea	MOP	Urea	20-20-20	All Fertilizers
	Public	Private	Public	Public	Public	Private	Private	Private	Public	Public	Public	Public	Public	Public	Private	Private	Public
	(US $/tonne)																
Transport costs	22	19	33	25	5	10	7	7	[a]	[a]	12	12	6	6	7	7	9
Storage costs	3	3	4	2	3	4	2	2	1	1	5	5	1	1	3	3	1
Handling costs	2	2	6	3	9	9	2	2	-	-	3	3	1	1	8	4	-
Physical losses	2	2	-	-	1	1	3	3	1	1	-	-	1	1	2	-	1
Taxes and levies	-	-	1	1	-	-	-	-	1[b]	1[b]	-	-	11	5	4	4	-
Interest costs	2	2	13	6	13	13	16	17	8	11	22	22	8	8	1	1	3
Promotional expenses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Other costs	14	14	-	1	-	-	2	2	7	7	-	-	5	5	17	5	-
Importers/Wholesalers' margin	-	-	3	3	6	7	30	30	-	-	2	2	7	7	8	3	-
Retail margin	11	11	5	5	-	2	10	10	9	9	8	6	5	5	10	1	-
Total Marketing Costs	56	53	65	46	37	46	72	73	27	28	52	50	45	39	60	28	18

a. Included in Table 3.
b. Bank Commission for Letter of Credit.
Source: FAO/FIAC: "Fertilizer Marketing Costs and Margins in Developing Countries, 1985-86," (1987).

Table 12b. **Marketing Costs and Margins in Africa and Latin America, 1985**

	East and Southern Africa				Northeast Africa		Central Africa		West Africa			South America	
	Madagascar	Tanzania	Zambia	Zimbabwe	Somalia	Sudan	Rwanda	Zaire	Burkina Faso	Gambia	Ghana	Argentina	Nicaragua
	16-16-16	Urea	Urea	AN	Urea	Urea	17-17-17	d	15-20-15	Urea	AS	Urea	d
	Public	Public	Public	Private	Public	Public	Public	Public	Public	Public	Public	Public	Public
	(US $/tonne)												
Transport costs	56	124	47	20	17	40	41	44	41	11	42	12	67
Storage costs	5	2	8	-	6	8	59	17	-	6	4	3	-
Handling costs	10	14	7	4	7	9	2	1	6	4	15	3	21
Physical losses	6	2	4	2	14	5	19	22	-	7	3	1	4
Taxes and levies	1	-	-	-	1	46	5	15	20	-	-	6	-
Interest costs	9	37	5	2	-	-	79	-	-	6	18	6	18
Promotional expenses	-	-	-	-	-	-	-	1	-	1	-	-	-
Other costs	14	3	4	7	1	1	3	1	-	12	2	-	-
Importers'/wholesalers' margin	10	39	-	13	11[a]	56	36	6	10	40	14	10	7
Retail margin	13	25	17	30	-	-[b]	24	-[e]	-	30	9	-	41
Total Marketing Costs	124	246	92	78	57	165	268	107	77[c]	117	107	41	158

a. All fertilizer in Somalia is distributed on an ad hoc basis by FAO and other projects which absorb some costs. The margin quoted is nominal.
b. Included in wholesale margin.
c. Probably understates true costs, which are absorbed by the cotton marketing organization, SOFITEX.
d. Average of all imports.
e. Included under wholesale margin.
- = nil or negligible.
Source: FAO/FIAC: "Fertilizer Marketing Costs and Margins in Developing Countries, 1985-86," (1987).

Table 13. **Fertilizer and Crop Prices, 1985/86**

	Urea	Maize	Rice	Wheat	Kilograms of Crop Output Required to Buy 1 kg of N Through Urea[a] Maize	Rice	Wheat
	-----(US $/tonne)-----						
Africa							
Burkina Faso	128	153	259	-	1.80	1.07	-
Cameroon	98	177	440	-	1.20	0.48	-
Kenya	231	116	158	164	4.33	3.18	3.06
Madagascar	282	63	134	282	9.73	4.57	2.17
Zambia	135	81	120	-	3.62	2.45	-
Zimbabwe	247	110	173	-	2.25	3.10	-
Average	186.5						
Asia							
Bangladesh	185	-	173	165	-	2.32	2.44
Burma	42	96	61	224	0.95	1.50	0.41
India	177	124	234	180	3.10	1.64	2.13
Indonesia	95	99	154	-	2.99	1.34	-
Malaysia	164	-	278	-	-	1.28	-
Pakistan	152	139	161	186	2.37	2.05	1.78
Philippines	251	150	173	-	3.64	3.15	-
Average	152.3						
Latin America							
Argentina	189	72	157	81	5.71	2.62	5.07
Brazil	250	90	188	-	6.04	2.89	-
Colombia	248	320	335	249	2.81	2.94	2.17
Mexico	84	124	116	105	1.47	1.57	1.74
Venezuela	40	187	158	-	0.46	0.55	-
Average	162.2						
World[b]	136	112	216	173	2.6	1.4	1.7

a. 1 kg N = 2.1739 kg urea.
b. f.o.b. N.W. Europe.

Source: IFDC Price Survey.

The marketing and distribution costs were 240% higher in Tanzania than in the Philippines in 1985. Likewise, in Rwanda, these costs averaged $268/tonne for NPK (17-17-17) compared with $28/tonne for NPK (20-20-20) in Thailand–nearly 10 times more. Except Somalia, not a single country in Africa incurred marketing costs lower than those in Asian countries. This indicates the need for improving infrastructural facilities in Africa. It should be mentioned that the data in Tables 12a and 12b do not include the transportation costs incurred by the farmers in moving the fertilizers from the retail level to the farm level. It is estimated that the farmers in Africa incur another 30% increase in cost for moving fertilizers from the retail level to the farm level.[5]

Thus, the cost of using fertilizers is very high in sub-Saharan Africa compared with that in Asia for three reasons. First, because many countries have small fertilizer markets, they pay very high prices for importing small quantities of fertilizers. Second, because infrastructural facilities are inadequate, the marketing and distribution costs are equally high in moving fertilizers from the border/port to the retail level. Third, because of the lack of rural roads, the farmers have to incur extra costs in moving fertilizers from the retail level to the farm level.

5. See FAO/FIAC: "Fertilizer Marketing Costs and Margins in Developing Countries, 1985-86," (1987).

Farm-Level Prices

Table 13 provides data on farm-level fertilizer (urea) and crop (wheat, rice, and maize) prices for various countries in Africa, Asia, and Latin America. These data are derived from IFDC's survey of monthly prices. A comparison of farm-level urea prices in Africa, Asia, and Latin America reveals that, although average urea prices were higher in Africa than in Asia or in Latin America, in three of the six African countries, urea prices were lower than world price as well as prices in some Asian countries (India, Malaysia, Pakistan, and Philippines). In the light of the analysis of import costs and marketing costs, these prices indicate that urea use was highly subsidized in Africa. Thus, although the costs of subsidies associated with using fertilizers are very high for the three reasons mentioned earlier, the farmer's costs of using fertilizers are not that high. Even in a country like Zambia, which is landlocked, the cost of urea to farmers was lower than it was in India or Malaysia (countries having production facilities). However, in countries where there was no subsidy, the farm-level price was rather high. For example, in Kenya, Madagascar, and Zimbabwe, urea prices were 30% to 60% higher than in India and about 140% to 197% higher than in Indonesia and Mexico.

Although these comparisons of absolute urea prices are revealing of the high cost of fertilizer use in Africa, they do not reflect the real cost of using fertilizers; because fertilizers are used as an input in crop production, cost must be calculated in relation to crop prices. Hence, a comparison of nitrogen and crop prices is pursued below.

In Table 13, the real cost of nitrogen (through urea) is indicated for three crops, namely, maize, rice, and wheat. The amount of crop output required to purchase 1 tonne of nitrogen (equivalent to 2.17 tonnes of urea) is defined here as real cost. These calculations provide a better picture of profitability of fertilizer use at the farm level.

For all three crops, there are wide variations in real cost of using fertilizers among different countries. For example, for maize, the real cost varied between 0.46 in Venezuela to 9.73 in Madagascar. Excluding Madagascar, the real cost of using nitrogen in Africa varied between 1.2 (Cameroon) and 4.33 (Kenya) for maize and between 0.48 (Cameroon) and 3.18 (Kenya) for rice. In Asia, these costs varied between 0.95 (Burma) and 3.64 (Philippines) for maize, 1.5 (Burma) and 3.15 (Philippines) for rice, and 0.41 (Burma) and 2.44 (Bangladesh) for wheat. Likewise, in Latin America, these ranges were between 0.46

(Venezuela) and 6.04 (Brazil) for maize, 0.55 (Venezuela) and 2.94 (Colombia) for rice, and 1.74 (Mexico) and 5.07 (Argentina) for wheat.

This comparison of real costs of nitrogen use indicates that at the prevailing crop and fertilizer prices (including subsidy) the real cost of using fertilizers (urea) at the farm level was not significantly higher in Africa than in Asia or in Latin America. However, this conclusion should be qualified in at least three ways. First, sorghum and millet are dominant grain crops of Africa; rice and wheat are not. Hence, the true cost of fertilizer use should be analyzed by using prices of these crops. Second, compound and complex fertilizers (NPKs) rather than single-nutrient fertilizers (urea) are more common in Africa, and the costs of complex fertilizers are usually higher than those of single-nutrient fertilizer (urea) used here. Third, for many countries, subsidies hide the true social cost of using fertilizers. Hence, maintaining these prices could involve heavy subsidies. In general, however, this analysis, despite its limited nature, would indicate that low fertilizer use in Africa is in part due to its import dependence and poor infrastructural facilities rather than to the pricing environments.

Summary and Conclusion

In this paper, an analysis of fertilizer supply and the pricing environment is pursued to identify the factors responsible for the fluctuations in fertilizer use in sub-Saharan Africa. Supply/demand balances in the year 2000 are also analyzed. The main findings of the paper are as follows.

1. Although fertilizer use increased at about 7% per annum during the 1970-86 period, fertilizer production showed very little growth during the mid-1970s and the mid-1980s. Consequently, the gap between consumption and production widened over time from 139,000 tonnes in 1969-70 to 1,014,000 tonnes in 1985-86.

2. Because of the limited growth expected in production capacity in the 1990s, the gap between consumption and production could widen over time unless decisions are made and implemented to promote production capacity in viable locations.

3. Because of the widening gap between production and consumption, sub-Saharan Africa relied heavily on fertilizer imports to fulfill its fertilizer requirements. Fertilizer imports increased rapidly during the 1970-86 period and accounted for more than 90% of its fertilizer use. However, such a heavy dependence on imports introduces two uncertainties in fertilizer supply and therefore in fertilizer use. The first uncertainty results from the volatility of world fertilizer prices and the second uncertainty from foreign exchange allocations and political commitment. Because of these uncertainties, fertilizer imports, despite rapid growth, show wide annual fluctuations of between -10.0% and 30%. These fluctuations in imports could be partly responsible for the fluctuations in fertilizer use that sub-Saharan Africa experienced during the 1970s and the 1980s. Further research on the means to reduce these fluctuations in imports may prove helpful in identifying the ways to sustain growth in fertilizer use in sub-Saharan Africa.

4. At the country level, the size of the fertilizer market is very small. Twenty-eight of the forty countries in sub-Saharan Africa imported less than 20,000 tonnes of fertilizer nutrients, and only six countries imported more than 50,000 tonnes of nutrients. The small size of the market results in high import costs. The c.i.f. prices of fertilizer products averaged 30% to 50% higher in sub-Saharan Africa than in Asia.

5. In addition to high import costs, the African countries also incur relatively higher costs in marketing and distribution of fertilizer products. Compared with the costs in the Asian countries, these costs in sub-Saharan Africa are severalfold. For example, in Sri Lanka, the distribution costs for urea averaged about $45/tonne, as against $92/tonne in Zambia and $246/tonne in Tanzania.

6. Despite high import and distribution costs, the farm-level prices in many African countries are not significantly higher than those in the Asian countries. Furthermore, the real costs of using fertilizers in Africa are also not higher than those in Asia. Thus, the pricing environment does not appear to be a factor in producing low and fluctuating levels of fertilizer use in sub-Saharan Africa.

L'Utilisation Des Engrais en Asie: Enseignements Tirés de l'Expérience de Quelques Pays

Raisuddin Ahmed

Résumé

Les objectifs de cet exposé sont d'une part: d'analyser (1) le rythme de croissance de l'utilisation des engrais dans quelques pays asiatiques, (2) les politiques qui sous-tendent cette croissance, (3) les facteurs déterminants qui contribuent au succès de ces politiques et (4) la pertinence de ces facteurs et politiques aux réalités africaines; d'autre part, de fournir une analyse comparative des expériences qui ont été réalisées au Bengladesh, en Inde, en Indonésie, aux Philippines, et en Thalande dans les domaines de l'approvisionnement et de l'utilisation des engrais.

La différence des résultats obtenus dans ces divers pays peut s'expliquer par (1) les politiques gouvernementales mises en oeuvre pour stimuler la demande d'engrais et assurer aux agriculteurs ur approvisionnement efficace, (2) les écarts dans l'utilisation réelle, et (3) le niveau potentiel de la consommation d'engrais dans chaque pays.

Les schémas qu'adoptent la plupart des pays asiatiques pour stimuler la demande d'engrais comprennent généralement: (1) des programmes de recherche et de vulgarisation, (2) des crédits agricoles, (3) le développement de systèmes d'irrigation, (4) la distribution de semences améliorées, et (5) des subventions.

Enfin, cette étude propose des recommandations pour le développement du secteur des engrais en Afrique, qui s'inspirent des enseignements tirés de l'expérience des pays asiatiques.

Les facteurs déterminants à cet égard sont: (1) l'engagement gouvernemental, (2) la demande d'engrais, et (3) l'approvisionnement. Un certain nombre de questions clé concernant l'utilisation des engrais ont également été explorées.

Fertilizer Use in Asia: Lessons From Selected Country Experiences

Raisuddin Ahmed

Introduction

The main objectives of this paper are to examine (1) the pace of growth in the use of fertilizers in some Asian countries, (2) the policies underlying the growth, and (3) the critical factors that contributed to the success of policies and the relevance of similar policies and critical factors to African conditions. The selection of Bangladesh, India, Indonesia, the Philippines, and Thailand to represent the Asian experience is based on accumulated knowledge built through past and ongoing country studies at IFPRI. Thailand was included to reflect some interesting contrasts, although IFPRI's knowledge about that country's fertilizer sector is not comprehensive.

Trends in Fertilizer Consumption and Underlying Factors

Comparative Trends in Fertilizer Use

A comparison of trends and levels of fertilizer use in the selected Asian countries is shown in Table 1 and Figure 1. In India, Bangladesh, Indonesia, and Thailand, fertilizer use was low (3 to 10 kg/ha of arable land) in the early 1960s. The Philippines, on the other hand, achieved a higher level of application (19 kg/ha) during that time. During the two decades since then, India, Bangladesh, and the Philippines have reached application levels of 50 to 60 kg/ha. Indonesia has made the most progress; in 1985 it reached an application level of 127 kg/ha. Thailand has made only limited progress with application rates of 23 kg/ha. Thus, its current level is less than one-half that of India, Bangladesh, and the Philippines and only about one-sixth of Indonesia's level. In terms of annual growth rates in the application of fertilizers (1965-85), Indonesia ranks first (14.57%), Bangladesh second (12.5%), India third (11.08%), Thailand fourth (9.16%), and the Philippines fifth (3.0%). The lower growth rate in the Philippines than in Thailand reflects the higher starting base of the Philippines and the smaller starting base of Thailand.

The ranking of these countries shows that the pace of growth in fertilizer consumption is not quite consistent with the pace of growth in agricultural production (Table 2).

Table 1. **Trends of Consumption of Fertilizers in Selected Asian Countries 1961-1985**

Year	Bangladesh	India	Indonesia	Philippines	Thailand
	(NPK, kg/ha of arable land)				
1961-66	4.47	3.81	9.88	18.59	2.39
1967	10.79	7.29	10.00	25.00	8.62
1968	12.17	10.42	21.00	31.59	8.38
1969	14.53	12.38	13.79	30.78	8.75
1970	16.09	13.56	18.46	30.57	6.58
1971	12.83	16.41	17.46	43.51	10.29
1972	20.44	17.18	33.58	39.22	12.09
1973	20.44	17.51	35.00	51.71	10.71
1974	14.46	16.30	35.14	40.64	13.74
1975	24.11	15.31	33.67	49.61	12.08
1976	26.47	20.50	34.79	33.62	15.04
1977	38.28	24.91	43.01	37.16	18.25
1978	39.93	27.41	53.85	41.61	7.87
1979	45.60	30.36	60.41	45.74	19.92
1980	46.78	31.75	82.60	43.84	18.22
1981	44.88	34.71	102.03	41.23	19.93
1982	52.48	35.59	107.21	43.58	21.74
1983	62.57	40.20	101.06	45.73	27.87
1984	66.47	48.52	120.90	33.16	26.27
1985	61.01	51.37	127.54	58.44	23.40

Source: FAO Fertilizer Yearbook.

The inconsistency can be traced to a number of factors. First, the relative abundance of land in Thailand contributed to land-based growth in agricultural production, which was facilitated by Thailand's priority on road development. Second, because of a greater degree of openness in Thai and Philippine economies compared with others, there was a greater contribution from product specialization (e.g., cassava and rice in Thailand and coconut oil and sugarcane in the Philippines). Because our concern in this paper is fertilizer use, I shall refrain from a deeper analysis of sources of growth in agricultural production.

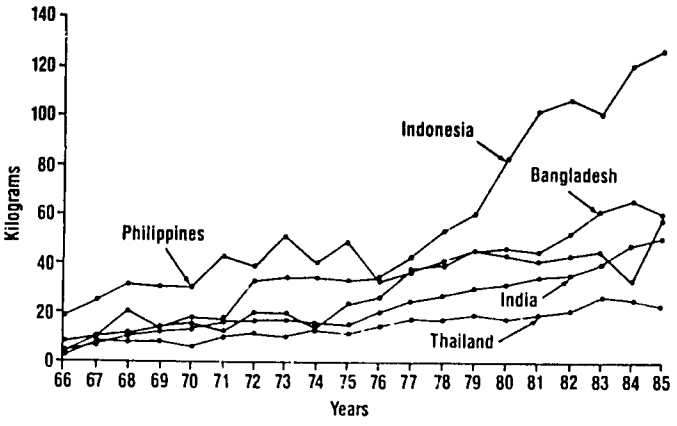


Figure 1. **Consumption of Fertilizer per Hectare of Arable Land.**

Table 2. **Ranking of Countries in the Growth of Fertilizer Consumption and Agricultural Production (1960-85)**

Country	Growth Rate in Fertilizer Use (%)	Rank in Fertilizer Growth	Growth Rate in Agricultural Production (%)	Rank in Growth of Production
Bangladesh	12.50	2	2.5	5
India	11.08	3	2.6	4
Indonesia	14.57	1	3.8	2
Philippines	3.00	5	3.6	3
Thailand	9.16	4	4.6	1

Source: Growth Rates of Agricultural Production from World Development Report, 1987, World Bank, Washington, D.C.

Policies Underlying the Success in Asian Fertilizer Sectors

The differential success of various countries in increasing fertilizer use for crop production can be explained by (1) the policies of governments in stimulating effective demand and ensuring an effective supply of fertilizers to farmers and (2) the extent of gaps in actual use and the potential level of fertilizer consumption in a country. This last point is important because the larger the gap, the greater is the possibility of achieving faster growth in consumption of fertilizers within a given set of policies (see Desai, 1982). This paper focuses on policies designed to stimulate demand and ensure supply. It is hoped that the changing emphasis among various elements of fertilizer policies, warranted at different stages of growth in fertilizer consumption, would be clear from the following discussions.

Policies to Stimulate Demand

The general mechanisms that most Asian countries employed in stimulating demand for fertilizers can be grouped into (1) extension and research programs, (2) agricultural credit, (3) irrigation development, (4) distribution of fertilizer-responsive seed, and (5) fertilizer subsidy.

In Bangladesh, fertilizer use was concentrated almost entirely in tea estates (consuming about 8,000-10,000 tonnes of ammonium sulfate per year) at the time of partition of India in 1947. The policies relating to widespread diffusion and stimulation of fertilizer demand can be described in proper historical perspective by arranging these policies into three phases: first phase – 1947-60, second phase 1960-70, and the third phase 1975-85. The period 1971-74 covers the civil war and internal disorganization in Bangladesh.

In the first half of the first phase (i.e., 1947-55), there was virtually no extension service at the field level. There were some agricultural inspectors (one for every 10-20 villages) whose main responsibility was to control jute acreage. An agricultural college and two agricultural schools with a combined capacity of less than 100 students operated in Bangladesh after partition. There was also the nucleus of a research system established before 1947. This research system was involved in plant breeding and fertilizer experiments on two or three government farms. Research priority was focused more on jute and tea than on rice and other crops. Fertilizer experiments involved trials with mustard cake, "bonemeal," ammonium sulfate, and cow dung. No irrigation development was initiated during this period. Similarly, institutional credit was effectively absent except for a half-hearted attempt to organize cooperative societies.

The second half of the first phase marks the beginning of planning in the economy. Agriculture began to receive systematic attention through the first plan even though the overall priority for agriculture was low compared with that for industry and infrastructural development. During this period, agricultural extension workers numbered one for every union (7-10 villages). The jute inspectors were given short courses in agriculture to enable them to serve as extension workers. The capacity of the agricultural college was doubled, and two more agricultural schools were established to provide short courses to jute inspectors and extend formal diplomas in agriculture to regular students in these institutions. Fertilizer trials were organized in a systematic pattern on farmers' land. However, no significant attention was given to improving the research system. Extension workers were often drawn into various

activities unrelated to extension work. A large-scale surface water irrigation project with a planned command area of 150,000 acres was started in this period. Low-lift surface irrigation with small pumps also began during this period. The agricultural credit system was not given similar emphasis, except that multipurpose cooperative societies were strengthened by increasing funds and reorganizing the cooperative department to give training to managers of cooperative societies.

During the second phase (1960-70), all agricultural development programs, especially the program for diffusion of fertilizer, were given a large boost. The agricultural extension service was strengthened by posting one worker for every five villages and increasing the supervisory staff accordingly. Mobility of workers was also improved by providing motorcycles or bicycles. Four more agricultural schools and two special training centers were developed to provide good training for workers. A village-aid system was introduced to coordinate the efforts of crop extension workers and workers for livestock, fisheries, and cooperatives. An agricultural university was established to cater to the needs of agricultural scientists and extension supervisors. The agricultural research system was expanded with a higher priority on rice research, but even then qualitative improvement of the research system was not the priority. During the latter part of the period, rice varieties developed at the International Rice Research Institute (IRRI) were available from the international research system. This was instrumental in creating an intense demand for improvement of the research system and better coordination of research and extension services. Similarly, the agricultural credit system was further strengthened by creating a specialized bank for agricultural credit and organizing a type of supervised cooperative system started at the Comilla Academy for Rural Development. During the period, credit in kind for fertilizers without any land collateral was introduced. Extension workers were supposed to organize demonstration plots for fertilizers, fertilizers for such plots were given free, and an award was given every year to the extension worker who organized the best demonstration plot in a district. For production of improved seeds, seed multiplication farms and a mechanism for supplying certified seeds were developed in every district. Regional fertilizer experiments were also organized for a large number of experimental farmers. Development of irrigated agriculture, mostly under public initiative and through low-lift small pumps, made tremendous progress. Tubewell irrigation was only at an exploratory stage. By the end of this period, the proportion of irrigated rice in the total rice area was about 10%.

Fertilizer pricing policy, as an instrument for stimulating demand for fertilizer, was consciously formulated in the mid-years of this phase. A subsidy rate ranging from 35% to 40% prevailed throughout the second half of the 1960s.

In the third phase of agricultural development in Bangladesh (1975-85), agricultural research received a particularly high priority. A Rice Research Institute was organized for research to meet the needs of various locations. Research scientists and agricultural extension officers were promoted in status and salary to make them equal to engineers and medical doctors. This yielded very good results. Initially the IR-8 variety of rice spearheaded the expansion in areas under fertilizer-responsive high-yielding varieties (HYV). Soon better varieties were developed in the wheat research program. Research and extension services developed coordinated programs for demonstration plots on farmers' fields. Irrigation development, particularly privately owned tubewells, made tremendous progress so that by 1985 about 20% of the rice area was covered by modern irrigation. A combination of irrigation and HYV, supported by the extension service and institutional credit, contributed to the rapid growth in fertilizer consumption during this period. The training and visit extension system was introduced in Bangladesh during this period, and the supply of institutional credit was almost doubled in real terms compared with that of the second phase (1960-70). Irrigation and HYV worked as direct and indirect accelerators in the use of fertilizers. The indirect effect of these two factors was much more powerful than the direct effect. Farmers who began to use fertilizers on irrigated HYV soon extended their use of fertilizer to non-irrigated local varieties. In fact, of the total consumption of fertilizers in 1984/85, about 60% was used on rainfed local varieties.

The subsidy policy to stimulate fertilizer demand was gradually restricted. The rate of subsidy at the beginning of this phase (i.e., 1975-78) was about 25%-30%. This was gradually reduced so that by 1985 there was virtually no subsidy for fertilizer in Bangladesh.

The foregoing story of Bangladesh can be considered as broadly representative of the process in India and Indonesia. Thailand appears to be a clear exception, and, to a lesser degree, the Philippines also differs from Bangladesh. Among these countries, Bangladesh is most constrained by agronomic and natural hazards such as flood, waterlogging, and drought. One-third of Bangladesh remains under water for about 6 months. The Philippines and some states of India come next in terms of agronomic and natural constraints. Keeping these factors in mind, it is perhaps appropriate to conclude that the different degree of success in stimulating demand for fertilizers in these countries can partly be attributed to different priorities and emphases accorded to agricultural extension, research, irrigation development, agricultural credit, and subsidy policy.

Thailand is an exception because the Government largely left the stimulation of demand for fertilizers to market mechanisms. Agricultural research and extension is still very underdeveloped in Thailand. There is only one extension worker for every 10-15 villages. The workers are usually without any significant agricultural education. Agricultural credit is also left to commercial banks and some multipurpose cooperative societies. Fertilizer subsidy was never adopted as an instrument for stimulating demand until recent years; since 1978, however, a subsidy of about 6% to 7% has been allowed on a selective basis. Development of irrigation by public policies has contributed to about 60% of the area currently covered by irrigation. About 20% of the net sown area of Thailand is currently irrigated. The proportion of HYV is very small (11%) compared to other Asian countries.

The national effort of the Philippine Government in the development of extension and research systems is quantitatively and qualitatively weaker than that of Bangladesh, Indonesia, and India but superior to that of Thailand. The International Rice Research Institute compensated for the deficiencies of the Philippine system. The Philippines has about one extension worker for every five villages and the backup training facility for workers is weaker than that in other countries, except Thailand. The Philippines, however, aggressively pursued a credit program for rice. Similarly, the Philippines accorded high priority to irrigation development so that about 60% of the rice area is now irrigated. This development and the HYV rice varieties from IRRI have supported growth in Philippine fertilizer diffusion. In terms of fertilizer subsidy, except during the oil crisis period of 1973-1975 when fertilizer subsidy was about 40%-50%, the Philippines taxed rather than subsidized fertilizer. It is estimated that the negative subsidy rate was about 10%, on the average, during the period 1977-81.

Indonesia's effort to stimulate demand for fertilizers parallels that of Bangladesh in extension, research, and credit. With respect to irrigation development spread of HYV, and fertilizer subsidy, Indonesia ranks far ahead of any other country discussed in this paper. Thus, more than 80% of Indonesia's rice area is irrigated, and about 90% is under HYV. The rate of fertilizer subsidy has ranged from 30% to 45% during the last decade.

India is a large country with considerable regional diversity. The difference between India and Bangladesh with respect to policies for stimulating demand for fertilizers is more significant in time than in style. Most demand-generating activities in India started earlier than in Bangladesh. Irrigation development in India is more extensive (about 30% of sown area) than in Bangladesh (20%). Subsidy was not an instrument to stimulate demand in India until the 1973 oil crisis. Thereafter, fertilizer subsidy ranged from 15% to 25% in recent years.

Policies to Ensure Effective Supplies of Fertilizer

I would underline the word effective to emphasize the importance of fertilizers being available at the right time and place. This implies that policies related to aggregate supply as well as to a farm-level distribution network are important facets of effective supply. Three elements essential to aggregate supply are (1) domestic production of fertilizer, (2) imports, and (3) stock. Similarly, importers, wholesalers, and retailers of fertilizers constitute the three links of a distribution network.

In Bangladesh the aggregate supply was entirely imported during the first phase (1947-60). However, during this phase a urea factory of 85,000 tonnes capacity was built, and production began in the second phase. Another factory was built in the second phase so that, by the end of the second phase (1960-70), about 50% of aggregate supply was provided from domestic production. The responsibility for all domestic production, import, and distribution was maintained by the public sector. At the beginning of the second phase, a specialized public organization, the Bangladesh Agricultural Development Corporation (BADC), was created and entrusted with the planning, procurement, and distribution of fertilizers, seeds, and agricultural equipment. During the third phase, further development of the domestic production of fertilizers occurred so that by 1985 Bangladesh exported about 100,000-200,000 tonnes of urea fertilizers annually and imported about 90% of phosphatic and 100% of potassic fertilizers. Overall, about 67% of the current requirement is met from domestic sources. Despite the decreased dependence on foreign sources of supply, BADC normally maintains an operating stock that meets at least a 6-month requirement.

With respect to distribution of fertilizers, the Agriculture Department organized seed stores at the Thana level (i.e., covering about 100 villages) during the first phase. Fertilizers were sold to farmers and cooperatives from these stores during the first phase. In the second phase, as volume of fertilizer sales increased, the BADC assumed the marketing responsibility. It organized larger godowns at Thana levels and appointed private dealers and cooperatives for the retailing of fertilizers to farmers at village level. However, if any farmer wanted to purchase directly from Thana stores, he could do so. Movement of fertilizers from central to Thana godowns used to be done mostly through private contractors. BADC was the only agency to procure fertilizers from domestic factories and to import, store, transport, and distribute fertilizer through its own outlets, private dealers, and cooperatives.

During the third phase, the above procedure was gradually changed to induce private trade in fertilizer marketing. Currently BADC maintains the overall planning and the monopoly on imports. It also maintains stocking responsibility. All wholesaling and retailing of fertilizers, with no price control for farm level sales, are now conducted by the private sector. Wholesalers can directly obtain fertilizers from domestic factories.

The evolution of the supply systems in India and Indonesia is roughly similar to that of Bangladesh, but Thailand and the Philippines differ substantially from these three countries. India has been expanding domestic production of fertilizers since the late 1950s so that about 65% of current consumption of fertilizers is from domestic production. Indonesia exports about 20,000-50,000 tonnes of urea every year, and, overall, Indonesia meets about 75% of its requirement from domestic production. On the other hand, Thailand is dependent on imports for about 95% of its requirement, and the Philippines is dependent on imports for about 80% of its requirement. Until recent years, all domestic production of fertilizers in Bangladesh and Indonesia was in the public sector. About half of India's domestic production is in the private sector. Most of the domestic production in Thailand and the Philippines is in the private sector. The importing of fertilizer has been a government monopoly in India, Bangladesh, and Indonesia, but the private sector (mostly manufacturers) has been responsible for importing fertilizers in Thailand and the Philippines. However, there is a greater degree of control and monitoring of private trade in the Philippines than in Thailand. In the Philippines, the Fertilizer Industry Authority (FIA) monitors supply, demand, and prices and also recommends tax or subsidy instruments to correct any imbalances, current or emerging.

The internal distribution of fertilizers is conducted mainly through private agents in Thailand and the Philippines. In Thailand, the wholesale distribution is conducted by trading companies, farmers' marketing associations, and the central cooperative association. The retailing is conducted by private traders (36%) and cooperatives (64%). In the Philippine fertilizer industry, the sugar producers' cooperative and marketing association conducts the wholesale trade, and retail trade is conducted by a dealer network (67%) and small traders and cooperatives (33%). In Indonesia, the wholesale trade is still under a number of public agencies, but the retail distribution is left entirely to private traders and cooperatives. In India, a great diversity exists among states. But cooperatives play a larger role in both the wholesale and retail distribution of fertilizers than they do in the other countries. India has a complex mechanism of allocating fertilizers among states. This allocation is conducted by the Government. After the allocation is known, cooperatives, dealers, and private agencies obtain fertilizers from factories and import points for sale to retailers who, in turn, distribute it to farmers. India also attempts to maintain uniform farm-level prices across regions.

Asian Lessons of Possible Relevance to Africa

Before trying to draw any lessons from the Asian experience that may be regarded as appropriate for contemporary African governments, two cautionary notes are in order. First, the experience of a country in one stage of the evolutionary process of fertilizer diffusion cannot simply be repeated in another country in a different stage of the process. Many African countries are presently in a stage where Bangladesh or India was 20 years ago. Second, even if some Asian countries experienced spectacular success in the diffusion of fertilizers, they encountered pitfalls in their path toward policy formulation, and, in certain respects, policies could have been better. A country drawing lessons from other experiences should be careful about these pitfalls.

1. **Government Commitment** – It is clear from a comparison of country experiences that government commitment supported by actions does make a difference in the rate of diffusion of fertilizers. Of course, a country may have reasons not to attach a high priority to fertilizer as was partly true in the case of Thailand, but this does not appear to be true for most African countries. Direct measures by governments are needed to stimulate demand and ensure supply. Additional activities required from governments, which are not readily apparent, are the tasks of planning and monitoring of the fertilizer situation. Some organization in the government should continuously assess the technical potential of fertilizer use, monitor supply-demand balances in current and future years, as well as for the long term, and identify emerging constraints. Demand for fertilizers in the early stage of diffusion is of a rapidly changing nature. Short-term supply management often falters because of this problem.

2. **Weak Demand Side in Africa** – It is argued that the underlying agronomic and economic conditions are more congenial in Asia than in Africa for a rapid growth in fertilizer consumption. Asian soils, crops (rice and wheat), human capital, and price environment are, to some extent, more supportive of intensive agriculture than are those in Africa. Irrigated rice and wheat, particularly with new high-yielding varieties, provide greater profitability from use of fertilizers than do the rainfed, low-valued crops (millet, sorghum, traditional maize) generally grown in Africa. The foregoing proposition is considered only a partial truth. Maize, particularly high-yielding varieties of maize, is

known to be as fertilizer responsive as rice and wheat, if not more so. Moreover, there are numerous locations within most countries of Africa where agronomic conditions are equal to those in Asia. African peasant agriculture has received little attention compared with large-scale estate farming. The starting point in the generation of demand for fertilizers in Africa is the assessment of the technical potential of fertilizer requirements on a country by country basis, taking into consideration regional soil conditions and crop prospects under existing prices.

Assuming that the technical potential is high and known, the second step in policy is to organize agricultural extension, supported by a closely complementary research system, that will focus on stimulating demand in locations with high potential. The agricultural extension service must be provided with knowledge of fertilizer response, proper combinations, and all financial requirements for setting up demonstration plots in rural areas. Agricultural credit with mechanisms for interlocking fertilizer use and adoption of modern seeds with credit should be extended simultaneously. It is likely that these measures will face numerous hurdles in making an effective impact. Even these institutions may be inappropriate for specific conditions. For these reasons, governments should develop an organizational capacity in a certain department to establish and modify institutions and identify constraints to demand. In the early stage of fertilizer diffusion, Asian countries could induce FAO/UNDP to undertake fertilizer trials on an extensive scale. Such international efforts in Africa are limited, partly because of the limited absorption capacity in Africa and partly because of the inability and weaker commitment of governments to attract these international organizations to the African fertilizer scene. The relative weakness of African governments in stimulating demand and attracting international support can be traced to poorer infrastructural development in African countries compared with Asia. This is a key factor that can be considered only within the context of overall economic development.

Most Asian countries have, at one time or another, employed fertilizer subsidies to stimulate demand. Given the technology and infrastructure in Africa, the logic for subsidies at the present stage of fertilizer diffusion appears to be stronger in many African situations than for Bangladesh or Indonesia in the early 1960s. This is, however, an issue that requires examination in specific country contexts without any ideological bias.

3. **Deficient Supply System Underlying African Scene**– Ensuring an effective supply of fertilizers at the farm level is considered to be the most critical factor in accelerating agricultural growth through intensive use of fertilizers (see the article by Desai and Stone, 1987, for articulation of this position). In our presentation of Asian experiences, this has been shown to be an important factor in explaining the differential levels of diffusion of fertilizers among selected Asian countries.

The question of how to effectively ensure fertilizer supply to farmers invariably leads to the issue of the role of government and the privatization of fertilizer trade. The question of fertilizer subsidy is also interwoven with the question of privatization. Asian experience clearly indicates that without direct or indirect government intervention, the pace of fertilizer consumption becomes slower (e.g., Thailand).

Theoretically, it is possible to visualize the following models for supply of fertilizers:

1. All supply functions (national level procurement, i.e., import in case of most countries, and wholesale-retail distribution) are left to the markets, and governments retain influence only through tax or subsidy policies.

2. All supply functions (aggregate procurement as well as retail and wholesale distribution) are undertaken directly by government.

3. The second model remains in operation, but unrestricted private trade is allowed to work with public operations.

4. Government retains the functions of aggregate procurement (production and importation) and stocking at prominent wholesale points but distributes to farmers through a network of private traders, including cooperative societies.

An examination of the models in the context of Africa cannot be complete without consideration of the following facts. First, dependence on imported fertilizers is very extensive in many countries of Africa. This creates more complexities and uncertainties in the aggregate supplies than when domestic production is the source of supply. Second, the volumes of trade involved in importing as well as in village-level distribution are often too small for healthy competitive markets. A thin market is not congenial for deriving benefits from economies of scale and is generally unstable. Third, the cost of transporting fertilizers from foreign ports to farmers in villages of Africa is about three to five times the cost in Bangladesh or India. Fourth, demand for fertilizer is extremely unstable in most African countries because of the dependence of agriculture on rainfall and the extreme variability of that rainfall. The issue of buffer stocks of fertilizers in the

African context is thus much more realistic than it is in the Asian context. Finally, the development of indigenous trade entrepreneurship is something that cannot be achieved in a short span of time. Many African countries are known for deficiencies in entrepreneurship.

Given these inherent problems, and the general practice of rigid control of foreign exchange, it is very unlikely that model 1 could be appropriate for most parts of Africa. On the other hand, model 2 could be extremely costly, particularly in countries with severe shortages of personnel with administrative skills. Model 4, perhaps, would be realistic for management of fertilizer supply in Africa.

Concluding Observations

This paper has analyzed and described the experiences of some Asian countries with regard to fertilizer diffusion. Because there is no equivalent experience in Africa, the paper draws some speculative conclusions regarding relevant lessons for African policies. The conclusions require confirmation or rejection through further studies in Africa. These studies should consider the following questions:

1. Is there a capacity in the government to plan, monitor, and analyze the fertilizer sector and act as a promoter of fertilizer policies?

2. What is the technically feasible potential of fertilizer demand region by region, given the existing price environment? What is the scope of reducing the gap between the actual and potential by price adjustments and by improvement in non-price factors?

3. How can the extension and research services be more effective for accelerating the diffusion of fertilizers? Is the extent of demonstration plots and field trials with fertilizers adequate?

4. How can the agricultural credit system be more effective for the use of fertilizers? Is there any scope for linking credit with fertilizer distribution?

5. Is the diffusion of fertilizer-responsive seeds stagnant? If so, why and how can it be improved?

6. In the context of the general deficiency in infrastructure and technology, would it be appropriate to continue a fertilizer subsidy policy as a short-run device?

7. How can a reliable mechanism be developed for a steady supply of fertilizers at the national level? Would it be necessary to maintain a buffer stock of fertilizer as insurance against supply instability?

8. How can an effective distribution network be developed for supply of fertilizers at the farm level? Is it appropriate to privatize fertilizer distribution at this stage of fertilizer diffusion? If not, what combination of private and public trading arrangements is optimal?

These are obviously very broad questions, which can be more sharply focused and delineated for an analysis of fertilizer diffusion within a specific country.

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Aspects Agronomiques de l'Utilisation Des Engrais Minéraux et Organiques en Afrique Sub-Saharienne

A. U. Mokwunye, A. Bationo, et Paul L. G. Vlek

Résumé

Le potentiel du développement agricole en Afrique tropicale dépasse largement les niveaux actuels de production. Dans cette région o seulement seize pour cent des sols ne présentent pas de sérieux problèmes de productivité, la baisse de la fertilité est devenue une cause majeure de la diminution des rendements agricoles. La capacité productive des sols que les agriculteurs ont pu maintenir grce à de longues périodes de jachère après une ou deux années de culture, est en plein déclin sous la pression de la population et de la culture continue.

L'azote et le phosphore sont les facteurs les plus limitatifs des sols d'Afrique tropicale. La teneur en azote à l'état naturel est fortement liée au niveau de matière organique des sols, qui varie de moins 0,1 pour cent dans les zones semi-arides à plus de 10 pour cent dans les régions forestières, à haute altitude et avec une forte pluviométrie. La carence en phosphore est plus aige dans les écosystèmes plus secs d'Afrique tropicale. La teneur totale en phosphore varie de moins 100 ppm pour les sols sableux à plus de 400 ppm pour les sols formés de roches basiques.

En 1983, le Centre international pour le développement des engrais (IFDC) a initié une recherche sur les ressources et la gestion des engrais azotés et phosphatés en collaboration avec des organismes nationaux du Niger, du Nigeria, du Burkina Faso et du Togo. Cette recherche s'est étendue à quatorze pays ouest africains à travers le Réseau ouest africain pour la gestion et l'évaluation des engrais (WAFMEN) et à huit pays de l'Afrique du Sud-est à travers le Réseau de recherche sur la gestion et l'évaluation des engrais en Afrique de l'Est et du Sud-est (ESAFMEN). Les recherches menées à travers ces réseaux ont généré d'importantes informations concernant (1) l'efficacité de l'urée et de l'ammonitrate (CAN) comme sources d'azote pour la production agricole dans les zones humides et sub-humides; (2) l'importance du temps et de la méthode d'application pour accroître l'efficacité de l'azote; (3) l'efficacité agronomique des phosphates naturels broyés et des phosphates partiellement acidulés (PAPR) à partir des minerais du Togo, Burkina Faso, Sénégal, Mali, et Niger; et (4) la gestion et l'utilisation des engrais organiques et des résidus de culture comme sources alternatives et complémentaires d'éléments nutritifs pour accroître la production agricole et maintenir la fertilité des sols.

Les objectifs du programme agronomique de l'IFDC-Afrique sont les suivants: (1) identifier les besoins en engrais des principales cultures à l'intérieur des différentes zones agroécologiques de la région, (2) évaluer les produits fertilisants et les pratiques de gestion susceptibles de couvrir ces besoins et promouvoir l'utilisation des ressources locales, (3) analyser les effets à long terme de l'utilisation des engrais sur la productivité des sols et l'environnement, et (4) promouvoir et développer des programmes nationaux de recherche et de vulgarisation.

Agronomic Aspects of Mineral and Organic Fertilizer Use in Sub-Saharan Africa

A. Uzo Mokwunye, A. Bationo, and Paul L.G. Vlek

Soil Fertility and Crop Production

The potential for crop production in tropical Africa far exceeds current production levels. There are several reasons for this anomaly. According to the Food and Agriculture Organization of the United Nations (FAO), only 16% of the soil resources of Africa have no serious limitations for crop production. In particular, low soil fertility has become a primary cause of reduced crop yields.

Soils of sub-Saharan Africa have been formed from Precambrian parent materials, volcanic ashfalls, and materials that have undergone several stages of pedogenesis through the processes of erosion and redeposition. In the terminology of the pedologist, most of the soils belong to the orders Alfisols, Ultisols, Oxisols, Entisols, and Inceptisols. The Ultisols are found mostly in the areas of highest rainfall. They are highly weathered and very acidic. Because of abundant rainfall, most of the basic minerals have been leached out and therefore the inherent fertility is very low. Tropical Alfisols occur in the somewhat drier bimodal or monomodal transition zones between the forest and savanna zones as well as in what has been traditionally called the guinea savanna zones. Because of lower rainfall, they have a higher base status than the Ultisols. They are less acidic and have relatively higher nutrient content. However, the Alfisols have poor structural stability, poor water-holding capacity, and low organic matter content. The Oxisols occur in the same high-rainfall zone as the Ultisols. They are more heavily textured and are structurally more stable. As a result, Oxisols are better drained and less subject to erosion. They are, however, as infertile as the Ultisols.

The Alfisols, Oxisols, and Ultisols are characterized by the dominance of low-activity clays. Because these clays have variable charges, the cation exchange capacity of the clays changes drastically with changes in the pH of the soil solution. This low buffering capacity causes management problems when the soils are cleared of vegetation and cultivated. Table 1 summarizes the extent of the major soils of tropical Africa. It can be seen that the less weathered and relatively more fertile soils occupy regions with a shorter growing season. On the other hand, the soils in the regions with a longer growing season and increased rainfall have lower suitability for crop production.

Table 1. Extent of Major Soils of Tropical Africa (Based on Data in Volume 1 of the Agro-Ecological Zones Project, FAO, 1978)

Soil Association Dominated by	Forest Zone: Growing Period ≥ 270 Days		Wooded Savanna: Growing Period 150-269 Days		Grassland Savanna: Growing Period 75-149 Days	
	Area	%	Area	%	Area	%
	(10^6 ha)		(10^6 ha)		(10^6 ha)	
Oxisols	176.7	54.7	137.8	42.7	3.6	1.1
Ultisols	63.8	42.7	72.8	48.7	10.2	6.8
Alfisols	35.8	12.7	178.9	63.3	26.2	9.2
Entisols	57.3	9.6	89.7	15.1	86.8	14.6

Over the years, farmers have maintained the productive capacity of these soils by resting them for long periods after one or two years of cropping. Thus, restoration of soil fertility was the major motive for shifting cultivation by traditional farmers. Nonavailability of arable land resulting from increased population pressure is causing farmers to resort to continuous cultivation. Scientists have documented numerous observations of serious declines in soil fertility associated with continuous cultivation. Most of these observations have come from experiment stations. For example, in West Africa, losses were reported for (1) organic carbon by Djokoto and Stephens (1961), Charreau and Fauck (1970), and Jones (1971) and (2) cation exchange capacity and exchangeable cations by Bache and Heathcote (1969) and Mokwunye (1981). Jones (1972) has reported similar information for an Oxisol in Uganda (Table 2). A recent survey by Balasubramanian et al. (1984) of the fertility status of several upland cultivated and uncultivated soils in northern Nigeria (Table 3) provides evidence as to the decline in soil fertility on farmers' fields as a result of cultivation. In the southern guinea savanna zone, with the highest rainfall, nearly 50% of the bases were lost as a result of cultivation.

The need to produce more food for a rapidly increasing population, both urban and rural, also means that in many localities marginal lands are being brought under

Table 2. **Changes in Soil Fertility Parameters in an Oxisol in Uganda Following 3 Years of Continuous Cropping Preceded by 3 Years of Rest Period**

Parameter	Changes: After Rest Period	Changes: After Cropping
	----------(kg/ha)----------	
Organic C	+15,950 ± 2,850	-19,700 ± 1,151
Total N	+769 ± 149	-968 ± 220
Total P	+85 ± 53	-88 ± 40
Total sulfur (S)	+45 ± 39	-86 ± 25
Exchangeable Ca	+971 ± 360	-1,897 ± 270
Exchangeable K	+471 ± 129	-461 ± 165
Exchangeable Mg	+465 ± 175	-420 ± 84

Source: Jones, 1972.

Table 3. **Percentage Changes in Soil Fertility Parameters in Farmers' Fields as a Result of Cultivation in the Savanna Zones of Nigeria (0-15 cm)**

Zone	Exchangeable Cations: Ca	Mg	K	pH
Sudan	-21.0	-32.0	-25.0	-4.0
Northern Guinea	-18.6	-26.8	-33.0	-3.8
Southern Guinea	-46.0	-50.6	-50.0	-10.0

Source: Adapted from Balasubramanian et al., 1984.

cultivation. In the meantime, new, improved, higher yielding varieties of such staple crops as maize and cassava are becoming increasingly available to local farmers. These new cultivars have a higher demand for soil nutrients. It is no wonder that the maintenance and improvement of soil fertility has become a key factor in efforts to sustain agricultural development in tropical Africa.

Nitrogen and phosphorus are the two most limiting nutrients in soils of tropical Africa. The native nitrogen content of the soils is strongly related to the organic matter content, which varies with rainfall and altitude, among other factors. The range is from less than 0.1% in semiarid areas to over 10% in high-rainfall, high-altitude, and forest areas. The organic matter content and its distribution within the soil profile in the West African forest and savanna regions are shown in Figure 1. Prolonged fallows encourage the buildup of organic matter content, thereby improving nitrogen supply.

Deficiency of phosphorus is most acute in the drier ecosystems of tropical Africa. In some soils of the West African savannas and semiarid region, phosphorus deficiency is so acute that seedling growth virtually stops as soon as the seed's reserve of phosphorus is exhausted. The total phosphorus values range from less than 100 ppm for the sandy soils to over 400 ppm for soils formed from more basic rocks (Udo and Ogunwale, 1977). As was the case with nitrogen, soil organic matter plays a crucial role in the supply of native phosphorus to crops. An appreciable fraction of the total phosphorus in tropical African soils is in the organic form (Acquaye and Oteng, 1972; Ayodele and Agboola, 1983).

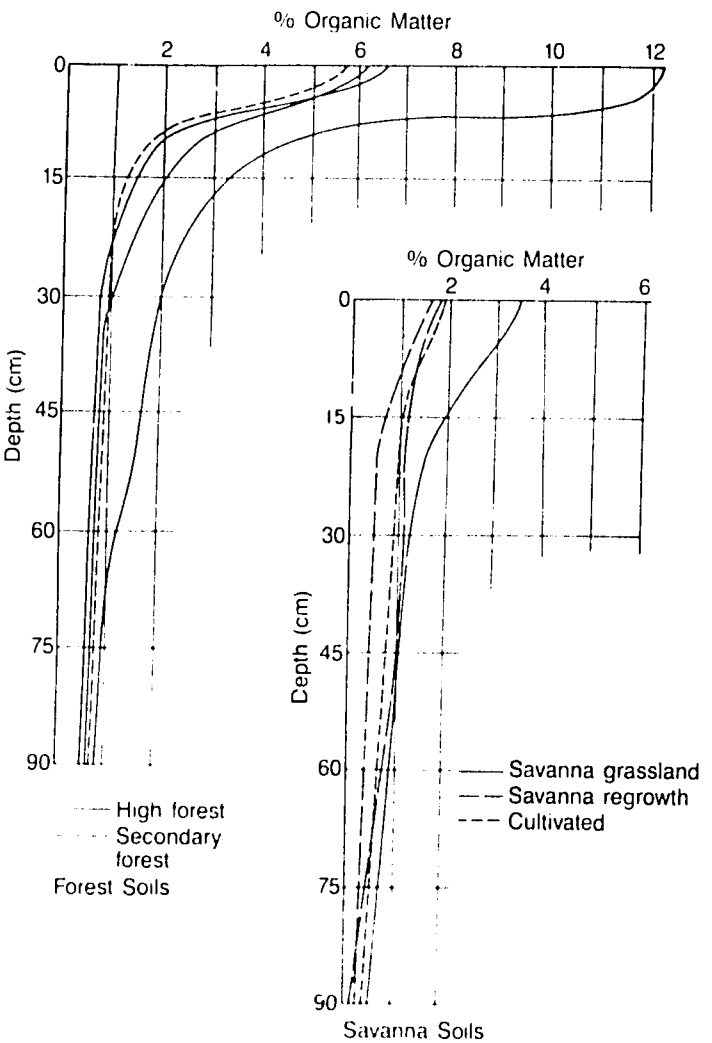


Figure 1. **Organic-Matter Distribution in Typical West African Forest and Savanna Profiles.**

Stable yields over time have been obtained throughout tropical Africa after repeated applications of even small doses of mineral fertilizers or larger amounts of manure. In the forest region of Ghana, Ofori (1973) reported that for 19 years crop yields were maintained on continuously cultivated land by application of small amounts of mineral fertilizers. The importance of balanced fertilization in continuously cropped land was amply demonstrated by the

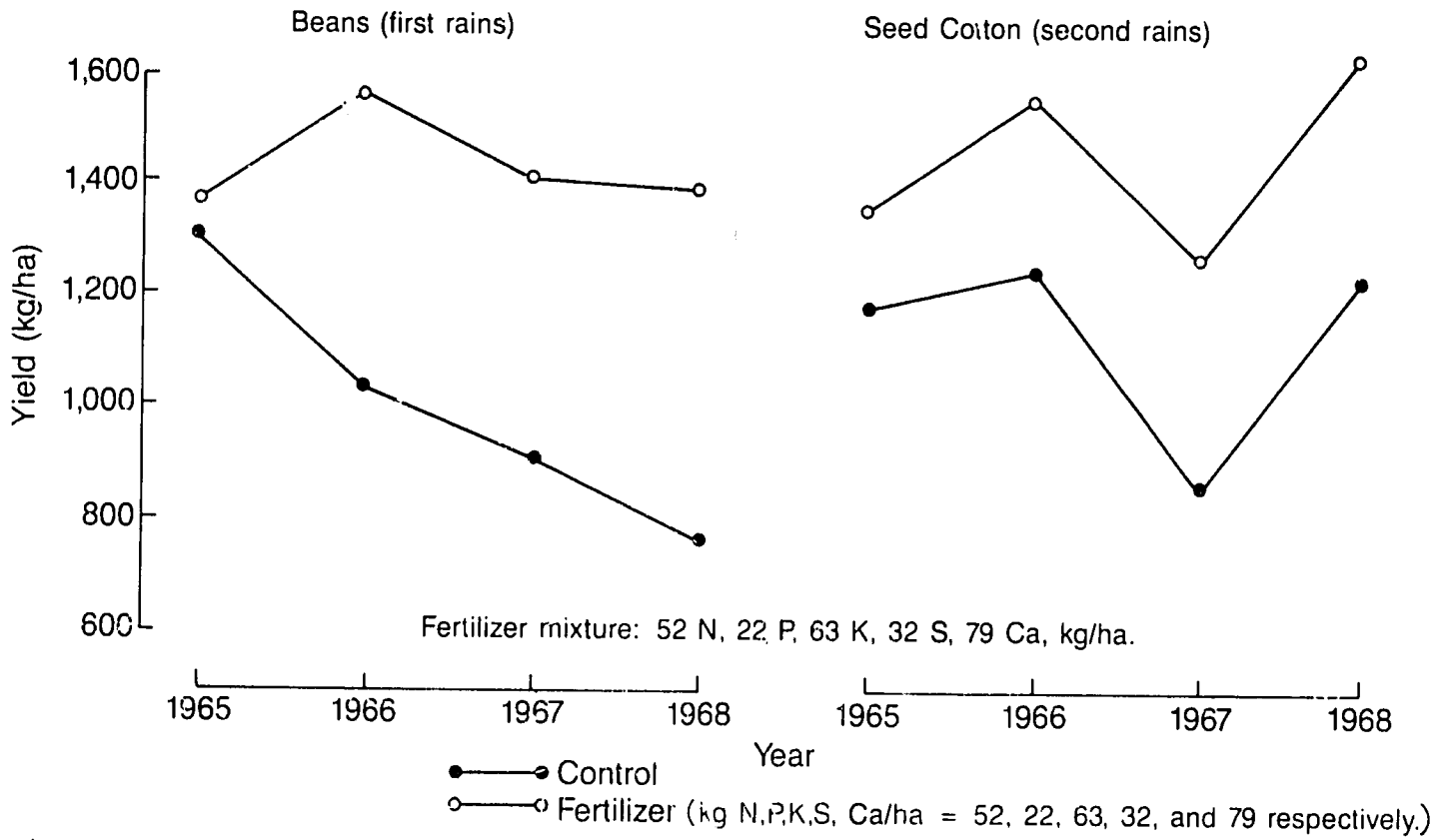


Figure 2. **Effect of Annual Fertilizer Additions on Continuous Rotations of Bean and Cotton Grown on a Red Ferralitic Soil in Uganda.**

work done by Jones (1972) in Uganda (Figure 2) and Kang et al. (1977) in Nigeria (Figure 3). On the other hand, in the sandy soils of the West African semiarid tropics, prolonged use of mineral fertilizers alone has resulted in acidification of the soils and consequent loss of bases (Pichot et al., 1981).

Recent IFDC Activities in Tropical Africa

Between 1970 and 1985, West African countries experienced two debilitating droughts. The effects of these droughts were so severe that policymakers and research workers alike began to lose sight of the fact that during the same period, even in years of adequate rainfall, crop yields had steadily declined. The cause of the yield decline was poor soil fertility. In 1982, the International Fertilizer Development Center (IFDC) organized, in collaboration with the International Institute of Tropical Agriculture (IITA) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), a fertilizer research program for tropical Africa. By 1983 collaborative research on the sources and management of nitrogen and phosphorus fertilizers was begun with national research organizations in Niger, Nigeria, Burkina Faso, and Togo. Today, research on the sources and management of fertilizers as well as other means of improving and sustaining soil productivity is being carried out in 14 West African countries under the auspices of the West African Fertilizer Management and Evaluation network (WAFMEN) and in 8 East and Southeast African countries under the auspices of the East and Southeast African Fertilizer Management and Evaluation Network (ESAFMEN).

Nitrogen Fertilizers—Results of field trials showed that response to nitrogen fertilizers was most dramatic in the subhumid zone of West Africa, which indicated that nitrogen deficiency is a major limitation to crop production in this zone. In the semiarid zone, water deficits and other deficiencies appear to limit the response to nitrogen. There was also lower response to nitrogen in the humid zone, which is a reflection of the higher organic matter status of this zone. Figure 4 demonstrates that, if other nutrient deficiencies are corrected, in the range of application rates where nitrogen fertilizer applications may be economic (linear response range), a farmer could expect to gain about 15 kg of grain per kilogram of applied nitrogen in the semiarid and forest zones, whereas returns per kilogram of nitrogen are twice as high in the subhumid zone.

Urea is the most common nitrogen fertilizer source in the tropical African market. The response of crops to urea and calcium ammonium nitrate (CAN) was monitored in

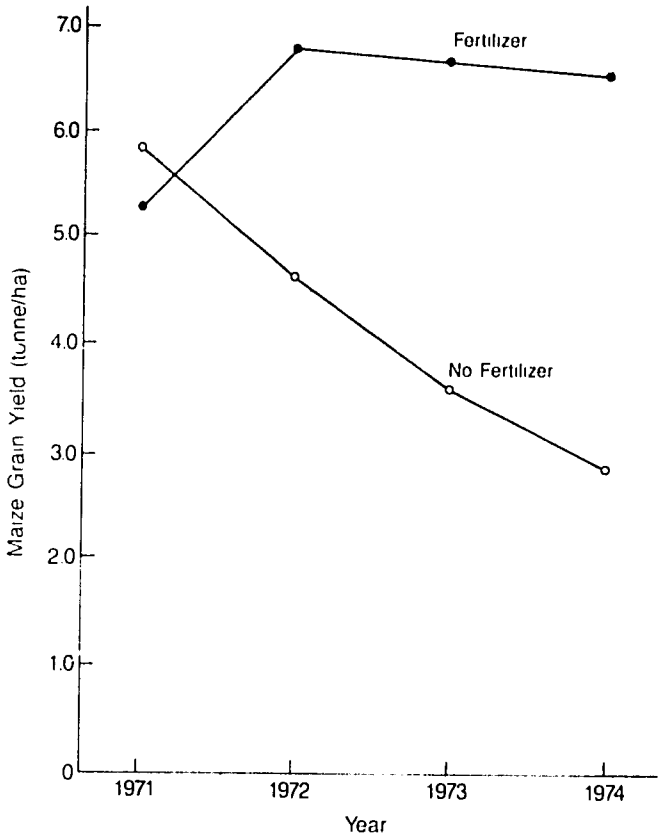


Figure 3. **Long-Term Effect of Fertilizer (120 N, 66 P, 30 K kg/ha per crop) on Maize Grain Yield Grown on an Alfisol in the Forest Zone of Nigeria.**

several field trials. Urea and CAN performed equally in both the humid and subhumid zones. In these zones, the cost of the fertilizer and its availability in the local market would determine the choice of nitrogen fertilizer by the farmer. In the semiarid zone, the less volatile CAN has tended to outperform urea.

Studies of nitrogen dynamics using ^{15}N-labeled fertilizers showed that loss of applied nitrogen occurred in all agroecological zones. However, losses are highest – as high as 50% – when urea is applied to the soils in the semiarid zone. The form in which the urea is applied also affects the quantity of nitrogen lost. Point-placed urea, especially when basally applied, experiences the highest losses, probably as a result of ammonia volatilization. More recent data suggest that CAN, when point placed and split applied, results in improved efficiency in nitrogen use. In general, therefore, the type of nitrogen fertilizer and its time and method of application can be manipulated to increase the efficient use of nitrogen by crops and to minimize losses. These observations are illustrated by data in Table 4.

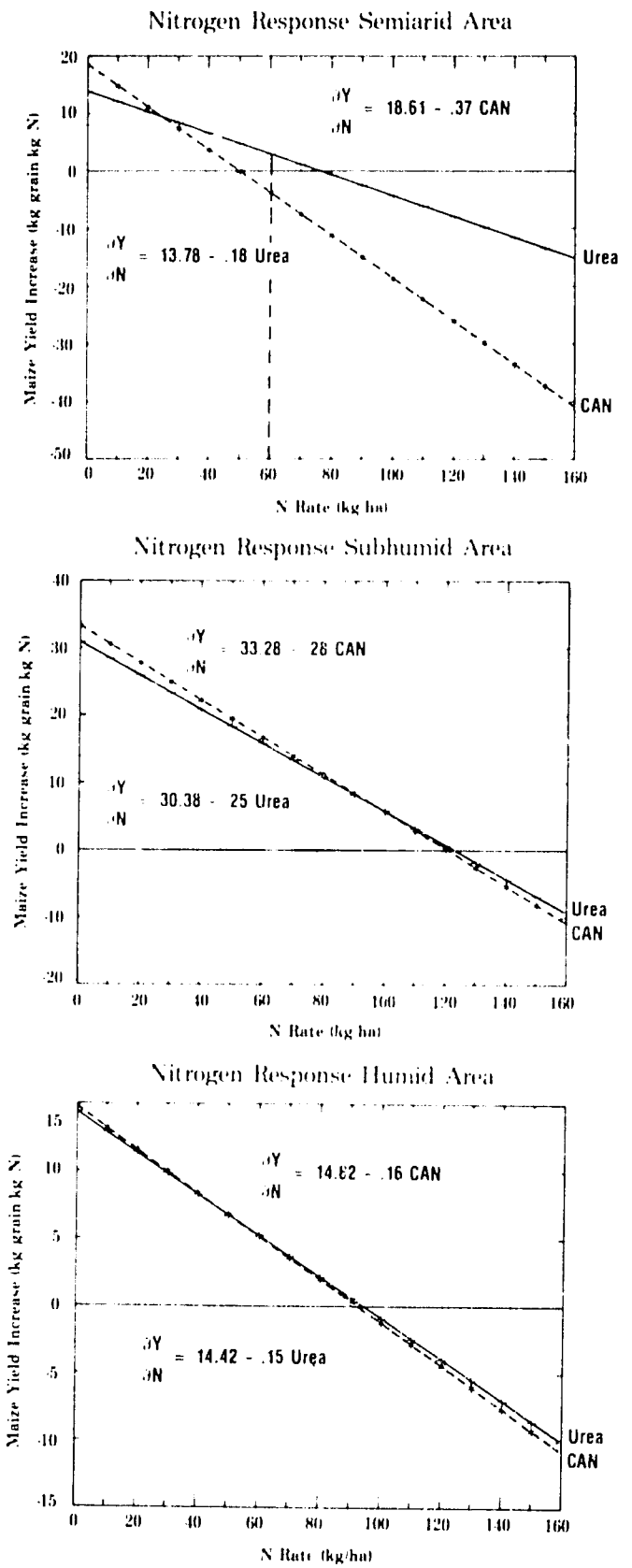


Figure 4. **Average Rate Functions for CAN and Urea in Various Climatic Zones.**

Table 4. **Effect of N Placement and N Source on Volatilization of Fertilizer N**

N Source	Application Method	N Volatilized (%)
Urea	Point surface	47a
Urea	Point 2 cm deep	49a
Urea	Point 4 cm deep	42a
Urea	Broadcast surface	24b
CAN	Point 2 cm deep	5b

Figures followed by the same letter are not significantly different (p = 0.05).

Phosphorus Fertilizers – Research on phosphorus fertilizers has concentrated on the use of local finely ground phosphate rock or their partially acidulated forms (PAPR) as less expensive alternatives to commercial phosphorus fertilizers. Over the years, finely ground phosphate rock from Togo, Burkina Faso, Senegal, Mali, and Niger have been evaluated in field trials. On the basis of agronomic effectiveness relative to the superphosphates, Matam phosphate rock (Senegal), Tilemsi phosphate rock (Mali), and Tahoua phosphate rock (Niger) are the most reactive of the West African phosphate rocks. When directly applied, these rock phosphates varied from 70% to 98% in agronomic effectiveness relative to single superphosphate (Table 5). They are therefore recommended for direct application. Phosphate rocks from Togo, Burkina Faso, and the Parc W region of Niger are unreactive and are not recommended for direct application.

Table 5. **Agronomic Effectiveness of Tilemsi and Tahoua Phosphate Rocks Relative to Single Superphosphate**

Phosphate Rock Source	Crop	Relative Agronomic Effectiveness[a] (%)
Tilemsi (Mali)	Groundnut	97.8
Tilemsi (Mali)	Maize	74.4
Tahoua (Niger)	Millet	70.0

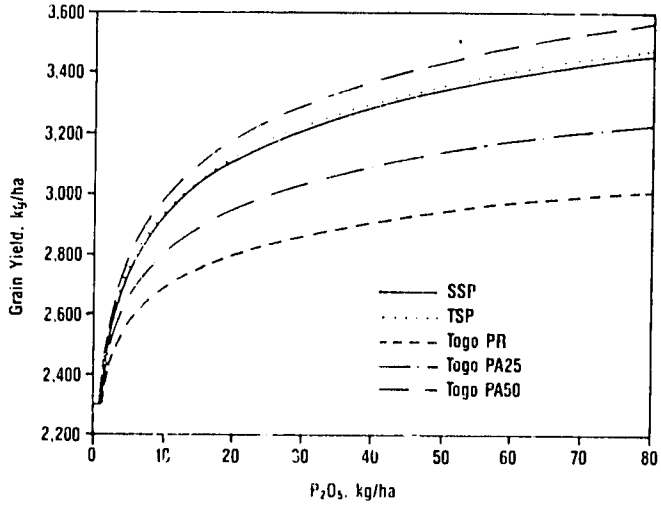
a. Single superphosphate = 100%.

Sulfuric acid-based 50% PAPR made using these unreactive phosphate rocks has been tested in several locations. Results shown in Table 6 and Figure 5 indicate that, in general, 50% partially acidulated products performed as well as single superphosphate. A general rule of thumb adopted by IFDC is that the cost of 50% PAPR is about 80% of the cost of SSP produced in the same location. With this as a guide, it can be seen that the use of PAPR could result in substantial savings in phosphate fertilizer costs.

Table 6. **Agronomic Effectiveness of Sulfuric Acid-Based 50% Partially Acidulated West African Phosphate Rocks**

Phosphate Rock Source	Soil Order	Crop	Relative Agronomic Effectiveness[a] (%)
Togo 50% PAPR	Alfisol	Maize	90.0
Togo 50% PAPR	Ultisol	Maize	66.7
Togo 50% PAPR	Oxisol	Maize	108.9
Kodjari 50% PAPR	Alfisol	Maize	84.1
Kodjari 50% PAPR	Alfisol	Sorghum	81.3
Kodjari 50% PAPR	Alfisol	Millet	108.9
Parc W 50% PAPR	Alfisol	Millet	93.4

a. SSP = 100%.



$\hat{Y}$ = 2298 + 163.03 (ln PR) + 213.29 (ln PA25) + 287.87 (ln PA50) + 268.85 (ln TSP) + 264.29 (ln SSP)
SE = 418 R^2 = 0.54 CV = 14.03

Figure 5. **Combined Analysis for Effect of Phosphorus Source and Application Rate on Maize Grain Yield – Oxisol.**

As can also be seen by the data in Table 6, soil type affects the response by crops to PAPR. Response to PAPR is lowest in Ultisols, which are very acid in reaction. Additionally, sulfur-deficient soils such as are prevalent in many savanna environments show higher

response to sulfuric acid-based PAPR as opposed to high-analysis fertilizers containing little or no sulfur (Figure 6).

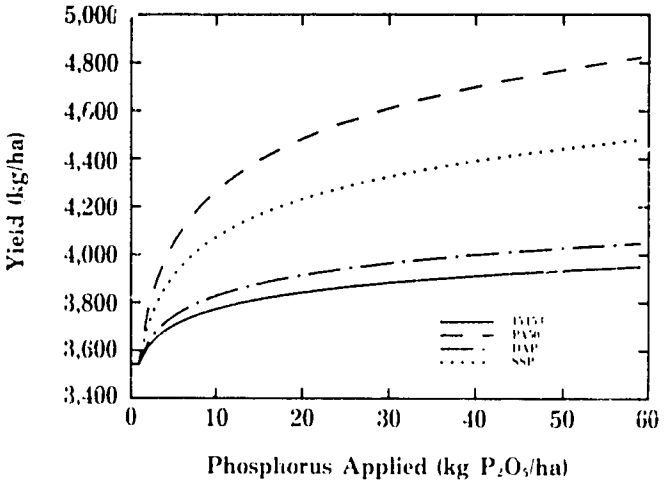


Figure 6. **Response to Phosphorus Source and Rate of Maize Grain Yield (Ikare, 1983 and 1984).**

Another interesting conclusion from the work on phosphorus fertilizers is that rates of phosphorus for optimum production are of the order of 60 kg P_2O_5/ha for the Alfisols, Oxisols, and some of the Ultisols. Ultisols containing allophane materials such as are found in the highlands of Cameroon and eastern Africa require more phosphorus. In the sandy soils of the semiarid zone, 30 kg P_2O_5/ha appears optimal.

Manures and Crop Residues–In the chemically fragile ecosystems of tropical Africa, the role of organic matter in controlling the sustainability of crop production cannot be minimized. All through the region, it has been shown that application of the right quantities of farmyard manure can improve and maintain crop yields (Pichot et al., 1981). But it must be pointed out that the practice of manuring involves the transfer of soil fertility from pastureland to cropland. Manures in themselves do not generate nutrients. The production of manure requires effective means of collecting, storing, and redistributing large quantities of already bulky materials. Where animals are stabled and fed, such a task is made easier. But the practice of herding without stabling, common to the nomadic populations of the Sahel and savanna regions of tropical Africa, does not benefit croplands. Rather, it can become a drain on soil resources, especially in populated areas, with potentially calamitous results in the case of overgrazing. Thus, although manures can improve and sustain productivity, the quantities required (of the order of 10 tonnes/ha) are high and cannot easily be obtained or handled by the farmer with only a hoe and a cutlass.

Calculations by scientists at Nigeria's Institute for Agricultural Research, Samaru, showed that for the 1970/71 crop year as much as 0.52, 0.07, 0.60, 0.15, 0.08, and 0.06 million tonnes of nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur, respectively, were removed by crops in the savanna zone of northern Nigeria. Only a small portion of the nutrients taken up by a crop ends up in the edible portions. Significant but variable quantities of plant nutrients are present in crop residues. For long-term fertility management of the soils, efforts must be made to study the effects of the use of these crop residues to promote sustainability of overall soil fertility. Earlier work (Pichot et al., 1981) has shown the beneficial effects of the addition of crop residues. These authors noted that while addition of straw alleviated some of the detrimental effects of continuous use of mineral fertilizers, the practice was not able to prevent soil acidification and subsequent loss of bases due to continuous cultivation.

Since 1983, IFDC had conducted a trial at the ICRISAT Sahel Center at Sadore in Niger on the effect of millet crop residues on crop production. During the first year, 4 tonnes/ha of millet straw was spread on the plots receiving the crop residues. Thereafter, the residues generated from these treatments were annually spread on the plots and left to decay. In 1983, addition of the crop residues alone only marginally increased millet yield. By 1986, the yield trends had changed dramatically. While yields from control plots had steadily declined, addition of either crop residue or fertilizers allowed the land to sustain moderate yields. In addition, there was no difference in yields between plots receiving chemical fertilizers and those receiving crop residues. More importantly, a combination of fertilizer and crop residues resulted in large significant increases in yield. The effects were additive (Figure 7). Data on soil pH after four consecutive crops are presented in Table 7. Significant increases in pH were noted in plots that received either crop residues alone or crop residues and fertilizers. Further soil analysis showed that these plots also had elevated levels of calcium, magnesium, and potassium. No significant differences in organic matter levels were found between treatments. Soil moisture studies conducted during the 1986 season failed to show any significant treatment effects, which indicated that crop residue did not improve yields during the first 4 years through improving the soil moisture-holding capacity.

Knowledge about fertilizer response by crops in different systems and environments forms the basis for economic analysis of fertilizer use which, in turn, forms the basis for fertilizer policy formulations. Promotion of fertilizer use must be based on scientific information developed through fertilizer-related agronomic and soil fertility research and sound economic and policy analyses.

The fertilizer promotion policy should include development of soil fertility maps, establishment of soil testing laboratories, formulation of soil- and crop-specific fertilizer recommendations, and initiation of well-designed fertilizer demonstrations under farmers' field conditions. At present, fertilizer recommendations for specific agroclimatic conditions, crops, crop technology, and soil conditions generally do not exist. The blanket recommendations for the whole country are not only inappropriate but could in fact be counterproductive.

Table 7. **Effect of Crop Residue and Fertilizer on Soil pH Sadore, Niger (1:1 Soil:N KCl)**

Treatment	1984	1985	1986
Control	4.16	4.02	3.99
Crop residue only	4.36	4.34	4.22
Fertilizer only	4.11	4.04	3.97
Crop residue and fertilizer	4.30	4.40	4.35
LSD (0.05)	NS	0.24	0.23

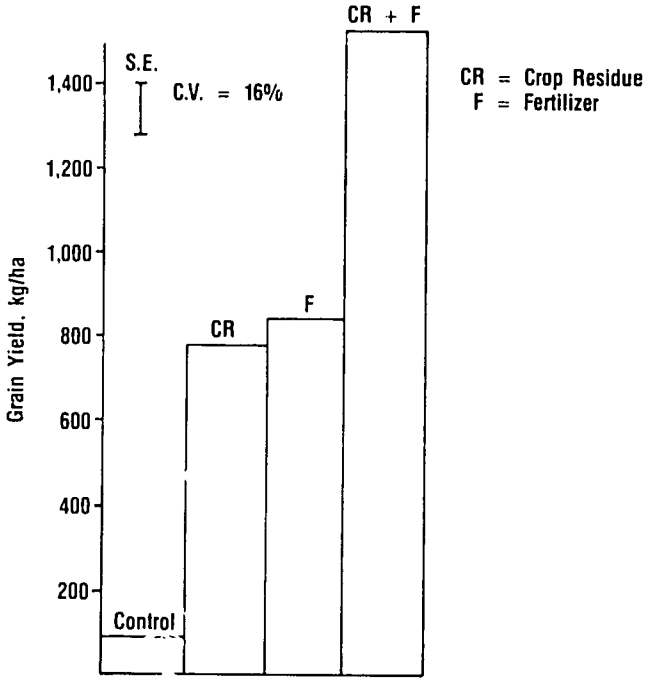


Figure 7. **Effect of Fertilizer and Crop Residue Application on Millet Grain Yield (Sadore, Niger, 1986).**

As we have already noted from the summary of the results of IFDC's work in tropical Africa thus far, the productivity of fertilizer use is heavily influenced by fertilizer management. Many countries in sub-Saharan Africa do have agricultural extension agencies of some sort that are assigned the job of fertilizer promotion and its efficient use. In many countries, the total expenditure on agricultural extension is larger than the expenditure on agricultural research, clearly indicating misplaced priorities (Boyce and Evenson, 1975). There is a need not to reduce the expenditure on agricultural extension but rather to substantially increase the expenditure on agricultural research.

Agronomic Program of IFDC-Africa

The major thrusts of the agronomic program of IFDC-Africa are in two areas: (1) revalidating and refining of existing information on fertility status of the soils as well as the fertilizer needs of the principal food crops and (2) generation of new information on fertilizer needs of soils and crops; the most economic fertilizer sources, preferably produced from local materials; and the long-term effects of fertilizer on soil productivity and the environment.

The objectives of the program are:

1. To identify, within agroecological zones of sub-Saharan Africa, the fertilizer needs of the important food crops.
2. To evaluate alternative fertilizers and fertilizer management strategies and encourage the use of indigenous resources to meet the fertilizer needs.
3. To study the impact of fertilizer use on long-term productivity of the soil and on the environment.
4. To promote the development of national programs on fertilizer research and extension.

If objectives 1, 2, and 3 are considered the body of the vehicle, objective 4 is the motor or the driving force. Close collaboration with national research and extension programs is a key to the success of the program. To this extent, there is heavy reliance on the establishment of fertilizer management and evaluation networks. Two such networks—West African Fertilizer Management and Evaluation Network (WAFMEN) and East and Southeast African Fertilizer Management and Evaluation Network (EASFMEN) are already in existence as mentioned earlier. Workshops and extensive training programs are organized for collaborating network members to enhance their ability to conduct fertilizer trials and to transfer new information to farmers.

IFDC scientists and their national counterparts have established benchmark experiments (BME) in the principal soil units within their zones. Information generated for a generalized soil unit and agroecological zone would

be adapted to local conditions through on-farm fertilizer evaluation. In this effort, research workers would be encouraged to work hand-in-hand with their national extension counterparts. This free-flow of information between IFDC scientists, their national counterparts in both research and extension, and the farmers is illustrated in Figure 8.

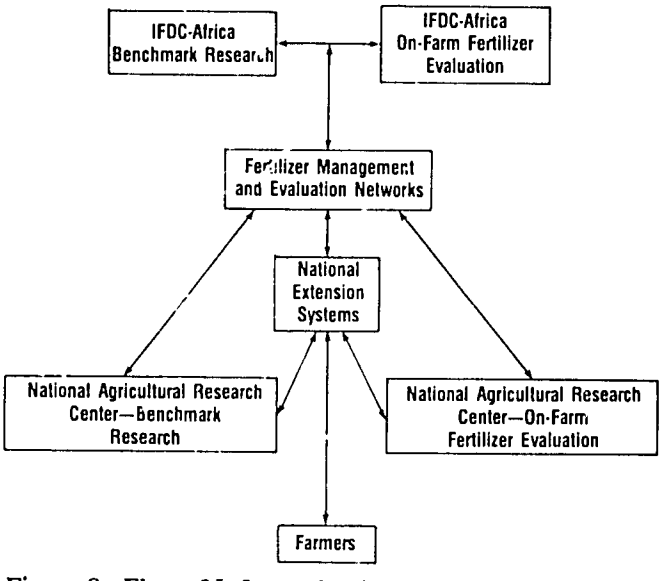


Figure 8. **Flow of Information Between IFDC Scientists and National Counterparts.**

Annually, collaborating national scientists and extension personnel are invited to "research planning" workshops. Results of the previous season's trials are analyzed and reviewed at these workshops, and programs for the oncoming cropping season are developed and adopted.

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Recherche Micro Socio-Economique Sur Les Contraintes à l'Utilisation Des Engrais en Afrique Sub-Saharienne et Développement de Politiques

Carlos A. Baanante et Thomas P. Thompson

Résumé

Le principal objectif de cet exposé est de développer et de présenter un cadre global pour la recherche micro socio-économique sur les contraintes à l'utilisation des engrais en Afrique sub-saharienne. Ce type de recherche est nécessaire pour permettre la formulation de politiques susceptibles de promouvoir l'utilisation des engrais et le développement agricole.

Ce travail s'articule autour de quatre sections portant sur (1) le cadre général de l'étude des contraintes à la demande d'engrais au niveau des agriculteurs, (2) les contraintes potentielles à la fourniture des engrais, (4) les issues méthodologiques et les limites de la recherche micro socio-économique, et (5) la portée de la recherche micro socio-économique dans les domaines de la conception et de la mise en oeuvre de politiques d'engrais.

Le cadre général de ce type de recherche est basé à la fois sur les principes de la théorie micro socio-économique et sur les concepts traditionnels de l'offre et de la demande. En élaborant ce cadre, cette étude établit les fondements pour une recherche approfondie sur les facteurs agroécologiques, sociaux et économiques qui conditionnent les décisions des paysans concernant leur production, et que les décideurs politiques doivent prendre en compte lorsqu'ils envisagent de promouvoir le développement agricole.

Les facteurs qui influent sur la production agricole et la demande d'engrais sont analysés dans le contexte de l'agriculture sub-saharienne, l'accent étant mis sur la diversité des climats, des sols et des environnements socio-économiques.

Les facteurs qui affectent la demande d'engrais sont: (1) la nature de la demande locale des produits agricoles et les prix de vente de ces produits qui déterminent la rentabilité des intrants achetés, tels que les engrais; (2) la disponibilité et le prix des intrants autres que les engrais, c'est-à-dire: la main d'oeuvre, la fumure organique, et les semences des variétés améliorées; et (3) le régime foncier, les crédits agricoles, et les services de vulgarisation. Les contraintes à la livraison des engrais au champ ont également été brièvement abordées.

Diverses approches méthodologiques pour conduire ce type de recherche ont été évaluées, y compris les études de cas, les panels, et les enquêtes exploratoires.

En conclusion, cette étude souligne l'importance de la recherche micro socio-économique pour le développement de politiques efficaces susceptibles de promouvoir l'utilisation des engrais et la production agricole en Afrique sub-saharienne.

Micro-Socio-Economic Research on Constraints to Fertilizer Use in Sub-Saharan Africa for Policy Development

Carlos A. Baanante and Thomas P. Thompson

Introduction

Sub-Saharan Africa comprises more than 40 countries with wide diversities in natural resources, agricultural sectors, and levels of development. The population of the subcontinent is in excess of 400 million and has experienced tremendous growth during the last two decades 1960-80 (United Nations, 1981). Sub-Saharan Africa is the sole region of the world where the annual rate of population growth actually increased, from about 2.5% in the 1960s to an estimated 2.8% in the 1970s (World Bank, 1981), and is currently about 3.0%. As a result of the rapid population growth and a limited expansion of food and agricultural production, per capita food production in most countries of sub-Saharan Africa decreased during the period 1971-84 (Table 1) and the dependence on food imports and emergency food aid programs increased.

The resource endowments and technologies that characterize agricultural production in sub-Saharan Africa show that (1) expansion in agricultural production through increased area of cultivated land is quite limited and (2) there is a great potential for expanding production by improving technology and increasing productivity. Fertilizer is a critical input for improving agricultural production technology and increasing crop yields.

However, sub-Saharan Africa has some of the lowest levels of fertilizer use in the world. As shown in Table 2, the average use of NPK (nitrogen, P_2O_5, and K_2O)/ha of arable land was about 5.7 kg during the period 1978-82. Zimbabwe had the highest rate, while only five other sub-Saharan countries used more than 10 kg/ha. Among 35 sub-Saharan countries, only 17 increased fertilizer use per hectare during 1974-82.

Given the low levels of fertilizer use in sub-Saharan Africa and the demonstrated contribution of fertilizers in increasing crop yields and land productivity, there is great potential to expand food production and promote agricultural development through the increased use of fertilizers. However, to realize this potential will require government policies, investments, and action programs that effectively promote the adoption and increased use of fertilizers by small-scale farmers.

The design and effectiveness of government policies and actions depend fundamentally on the availability of

Table 1. **Growth Rates of Per-Capita Food Production in 37 Sub-Saharan African Countries, 1971-84**

Country	Growth of Per-Capita Food Production 1971-79	1980-84
	(%)	
Angola	-2.2	-2.2
Benin	0.3	0.5
Botswana	-5.3	0.7
Burkina Faso	0.0	-2.1
Burundi	0.0	-3.0
Cameroon	-0.5	-2.1
Central African Republic	0.0	-1.2
Chad	-0.1	-4.2
Congo	-1.1	-1.7
Côte d'Ivoire	0.4	-1.5
Ethiopia	-1.6	-3.9
Gabon	-0.4	0.03
The Gambia	-5.5	2.7
Ghana	-3.5	-0.8
Guinea	-1.7	1.2
Guinea-Bissau	0.1	7.1
Kenya	-1.6	-2.0
Lesotho	-2.1	-3.8
Liberia	-0.5	-1.9
Madagascar	-0.5	-0.5
Malawi	-1.3	-0.7
Mali	-0.8	-1.6
Mauritania	-1.9	-3.4
Mauritius	0.8	1.7
Mozambique	-3.6	-3.9
Niger	0.0	-5.7
Nigeria	-0.7	-1.6
Rwanda	0.4	-1.2
Senegal	-4.4	2.9
Sierra Leone	-1.9	-2.7
Somalia	-4.6	-4.1
Sudan	0.4	-3.6
Swaziland	-1.1	0.7
Tanzania	-0.7	-3.4
Togo	-1.3	-3.2
Uganda	-1.2	0.7
Zaire	-1.5	0.6
Zambia	-1.9	-2.4
Zimbabwe	-2.8	-7.9
Total	-1.2	-2.0

Table 2. **Characteristics of Fertilizer Use in 35 Sub-Saharan African Countries, 1961-65 to 1978-82**

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Nutrient		Nutrient		1978-82 as % of	% Share of Total Use, 1978-82		
Country	1974-76	1978-82	1974-76	1978-82	1961-65	N	P	K
	- - - -(kg/capita) - - -		- - (kg/arable ha) - -					
Angola	1.10	2.17	2.00	4.30	430.0	48.8	27.1	25.6
Benin	1.10	0.53	1.70	1.10	550.0	51.5	27.3	21.2
Botswana	3.00	2.00	1.60	1.17	83.3	42.9	57.1	0.0
Burkina Faso	0.50	1.23	1.00	3.27	NA	32.7	41.8	23.5
Burundi	0.20	0.33	0.60	0.90	NA	51.9	29.6	22.2
Cameroon	1.80	4.40	2.20	5.37	670.8	52.2	17.4	31.1
Central African Republic	1.00	0.50	1.10	0.63	633.3	89.5	5.3	10.5
Chad	1.80	1.00	2.50	1.40	NA	42.9	21.4	31.0
Congo	2.30	0.37	4.70	0.90	47.4	59.3	11.1	33.3
Côte d'Ivoire	5.20	5.33	10.10	11.00	1,100.0	33.9	19.1	47.3
Ethiopia	1.00	1.13	1.90	2.60	2,600.0	38.5	61.5	0.0
Gabon	0.90	0.53	1.10	0.60	NA	44.4	11.1	33.3
The Gambia	2.20	4.30	7.70	16.43	4,108.3	31.6	62.1	5.9
Ghana	1.90	1.40	6.80	7.03	1,172.2	48.3	19.9	30.8
Guinea	0.30	0.27	1.00	0.87	144.4	23.1	42.3	30.8
Kenya	3.80	3.63	22.50	26.17	272.6	47.4	40.3	12.4
Liberia	2.80	1.53	12.80	7.70	1,925.0	55.8	28.1	16.0
Madagascar	1.00	1.33	3.00	3.93	262.2	43.2	18.6	38.1
Malawi	3.30	5.10	7.70	13.57	589.9	70.5	17.7	11.5
Mali	1.20	1.67	3.70	5.63	NA	50.9	21.3	29.0
Mauritania	0.50	0.67	3.70	5.83	NA	67.4	25.1	7.4
Mozambique	0.80	2.77	2.60	9.57	503.5	56.8	32.4	10.8
Niger	0.20	0.40	0.30	0.70	NA	42.9	42.9	9.5
Nigeria	0.80	1.87	1.80	4.87	4,866.7	52.1	30.8	17.1
Rwanda	0.00	0.13	0.40	0.47	NA	42.9	28.6	28.6
Senegal	8.40	4.33	8.40	4.70	106.8	28.4	42.6	30.5
Sierra Leone	0.70	0.30	1.10	0.77	766.7	34.8	34.8	34.8
Somalia	0.70	0.17	2.10	0.73	91.7	86.4	4.5	9.1
Sudan	4.90	2.63	6.40	3.93	106.3	99.2	0.8	0.0
Tanzania	1.90	1.70	6.10	5.67	515.2	59.4	25.3	14.7
Togo	1.10	0.90	1.70	1.70	NA	35.3	35.3	27.5
Uganda	0.30	0.03	0.40	0.07	9.5	50.0	50.0	0.0
Zaire	0.50	0.30	1.70	1.20	600.0	47.2	25.0	22.2
Zambia	12.20	12.93	11.90	14.87	707.9	68.6	22.4	9.2
Zimbabwe	22.70	19.50	56.00	55.33	199.8	51.0	28.6	20.5
Mean	2.12	2.33	4.17	5.73	347.7	51.3	30.3	18.4
Minimum	0.00	0.03	0.30	0.07	9.5	23.1	0.8	0.0
Maximum	22.70	19.50	56.00	55.33	4,866.7	99.2	62.1	47.3

Note: The means of columns (2) and (3) are weighted by country populations; the means of columns (4), (5), and (6) are weighted by country arable areas. The sums of columns (7), (8), and (9) for a given country may not add to 100% because of rounding errors. Sources of data are FAO Fertilizer Yearbooks, various years.

information and knowledge about the circumstances and behavior of farmers. Micro-socio-economic research to understand the farmers' decisionmaking processes and to identify constraints to fertilizer use is required for the design of effective government policies that promote fertilizer use and agricultural development. The lack of the type of information and knowledge which micro-socio-economic research can provide has contributed to the limited success, and often the failure, of programs and policies that were adopted to resolve the food production problems of sub-Saharan Africa during the last quarter century. The success of policies established in the context of macro-socio-economic planning or integrated rural development programs in sub-Saharan Africa has indeed been disappointing. Recognizing that micro-socio-economic research in sub-Saharan Africa is important and needed, a recent report from Michigan State University (Eicher and Baker, 1982) stated: "It is more evident than ever that long-run food and agricultural development strategies must be built on a solid foundation of micro research on small farmers, traders, and herders."

The main objective of this paper is to present and discuss a framework for micro-socio-economic research for the study of constraints to fertilizer use in sub-Saharan Africa. Such research will facilitate the development of effective policies to promote fertilizer use and agricultural development. For this purpose, the paper is organized into five sections concerned with (1) a general framework to study farm-level constraints to fertilizer use, (2) the potential constraints to farm-level demand for fertilizers in the context of sub-Saharan agriculture, (3) potential factors constraining the supply of fertilizers to farmers in the region, (4) methodological issues and limitations of micro-socio-economic research in sub-Saharan Africa, and (5) the implications of micro-socio-economic research for policy design and implementation.

A General Framework for Micro Research on Constraints to Fertilizer Use

In the most basic sense the actual use of fertilizers by farmers depends on two fundamental elements: (1) the desire and financial ability of the farmers to use fertilizers as a beneficial component for production of crops and (2) the availability and cost of various fertilizers. The first element determines the demand of farmers for fertilizers, and the second is determined by the supply of fertilizers. The actual use of various types and quantities of fertilizers is directly related to these two basic elements.

Therefore, the framework for micro-socio-economic research on constraints to fertilizer use is based on the demand for fertilizers by farmers, on the one hand, and the supply of fertilizers, on the other. This framework includes two basic components: (1) the analysis of the factors and circumstances that determine the behavior of farmers with respect to agricultural production and the demand for fertilizers and (2) the analysis of factors that influence and determine the supply of fertilizers available to farmers (see Figure 1). In the first component, micro-socio-economic research should identify the constraints to fertilizer demand and use among the diverse factors that affect agricultural production technology, the availability and use of resources, and the socioeconomic environment. Agricultural production economic theory provides the basic conceptual framework for conducting the micro-socio-economic research and establishing implications for policy development. This type of research involves the collection and analysis of data and information from samples of farmers who are representative of various sub-Saharan agroclimatic and socioeconomic environments. It has implications for the development of policies that can induce the adoption and increased use of fertilizers by modifying the circumstances and behavior of farmers, i.e., policies that affect the demand for fertilizers by farmers.

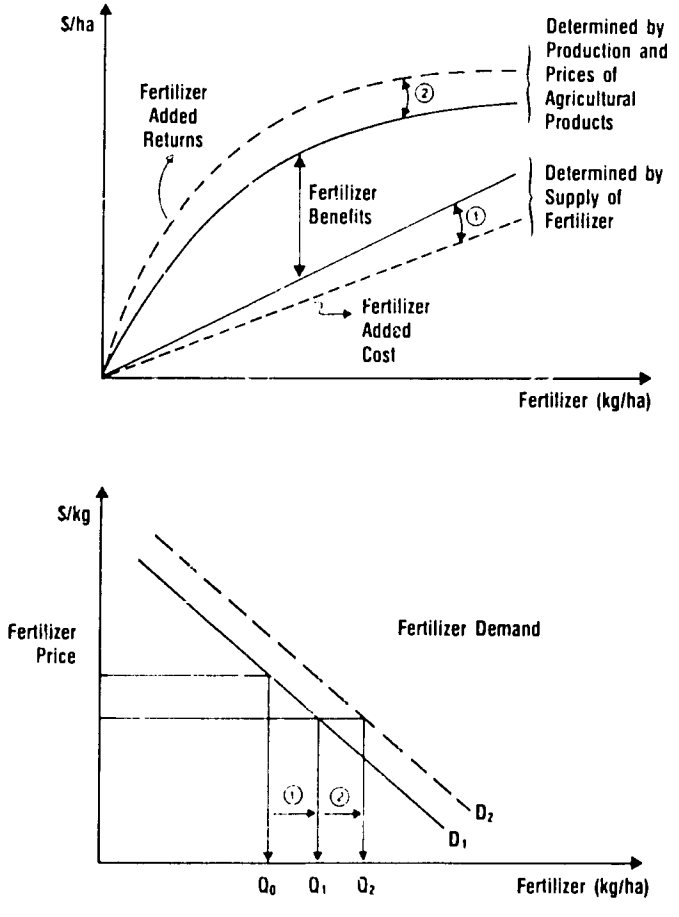

Figure 1. **Conceptual Basis of Framework for Micro-Socio-Economic Research on Constraints to Fertilizer Use.**

The second component concerns the study of the factors and circumstances that influence and determine

the supply of fertilizers available to farmers. This type of research concerns the analysis of factors that influence the production, importation, distribution, retailing, and pricing of fertilizers. Such research is necessary to identify problems and inefficiencies that constrain the supply and/or increase the cost of fertilizers. The knowledge and information that such research provides is necessary for the design and implementation of policy measures that can ensure an adequate supply of fertilizers to satisfy demands of farmers at the lowest possible cost. These policy measures should complement policies that attempt to promote fertilizer use by modifying the circumstances and behavior of farmers, and thus demand. This research involves the collection and analysis of data and information from public and private sector organizations that are involved in the production, importation, distribution, and pricing of fertilizers, as well as an assessment of the infrastructure and policies that affect the supply of fertilizers available to farmers.

Given the nature of research in each of these two components, it is evident that micro-socio-economic research is greatly needed to examine the factors that are constraints to fertilizer use as a result of their negative impact on the demand for fertilizers by farmers.

Farm-Level Fertilizer Demand Constraints

Fertilizers are variable inputs in agricultural production. Thus, the demand for fertilizers is derived from the demand for agricultural products. The factors that affect and determine agricultural production and the demand for fertilizers may be classified as (1) climatic factors, (2) soil characteristics, and (3) economic and social variables. These factors in conjunction with the knowledge and experience of farmers determine the decisions about the use of resources for agricultural production, such as crops and cropping systems, as well as the use and management of fertilizers and other variable inputs.

The agricultural production function and economic theory provide the basic conceptual framework for the study of potential constraints to agricultural production and fertilizer demand. The following general model of the agricultural production function is adopted for this purpose.

$$Yi = f(X1,....Xn, Z1,....Zm, W1,....Ws, K) \qquad (1)$$

where, crop production of a given i crop or cropping system (Yi) is expressed as a function of:

- the use of n variable inputs X1,....Xn, such as fertilizer and labor;
- the quantitative and qualitative nature of m short-run fixed factors of production Z1,....Zm, such as land and capital;
- exogenous and stochastic climatic factors W1,....Ws, such as rainfall and temperature; and
- the knowledge and experience of farmers (K).

Crop production (Yi) and the use of fertilizer and other variable inputs (X1,....Xn) by farmers depends on the availability, qualitative nature, and use of the short-run fixed factors of production (Z1,....Zm), perceptions about the occurrence and influence of stochastic climatic factors (W1.....Ws), the knowledge and access of farmers to information (K), and finally, a set of economic and social factors affecting the behavior of farmers. In the short-run, however, the knowledge of farmers and their perceptions of climatic factors are taken as given and constant. Then, the production function and the demand functions for fertilizers and other variable inputs are simultaneously determined by the technical input-output relationships, the "levels" of use and characteristics of short-run fixed factors of production, and the economic and social factors affecting the behavior of farmers, such as crop and input prices, land tenure, and the availability and cost of credit. Hence, in the short-run, the following functions are simultaneously determined:

a production function

$$Yi = f(X1,....Xn, Z1,....Zm)$$

and variable input demand functions

$$X1 = \emptyset\ (Px1, Pxn, Pyi, Z1,....Zm, E1....Eq)$$
$$X2 = \emptyset\ (Px1,....Pxn, Pyi, Z1,....Zm, E1....Eq)$$
$$\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
$$Xn = \emptyset\ (Px1,....Pxn, Pyi, Z1,....Zm, E1....Eq).$$

In addition to the input and crop prices (Pxj and Pyi), the demand for variable inputs is also affected by the short-run fixed factors of production (Z1,....Zm), and by a set of economic and social factors (E1.....Eq).

Since fertilizer is a variable input, the observed (ex post) farm-level response of crop output to fertilizer reflects not only the management and practices associated with the use of fertilizer, but also the influence of climatic variables and the levels of use and quality of other variable inputs and fixed factors of production. If the variable input X1 is the fertilizer quantity, the general fertilizer response and demand function models may be expressed as follows:

fertilizer response function

$$Yi = f(X1 / \bar{X}2,....\bar{X}n, \bar{Z}1,....\bar{Z}m, \bar{W}1,....\bar{W}s)$$

fertilizer demand function

$$X1 = \phi(Px1 / \bar{P}x2...\bar{P}xn, \bar{P}y, \bar{Z}1,....\bar{Z}m, \bar{W}1,....\bar{W}s, \bar{E}1....\bar{E}q)$$

The fertilizer response function shows the relationship between crop yield (Yi) and the quantity of fertilizer or plant nutrient applied (Xi) in a two-dimensional setting that is obtained at given levels of use of variable inputs ($\bar{X}2....\bar{X}n$), fixed factors ($\bar{Z}1....\bar{Z}n$), and climatic variables ($\bar{W}1....\bar{W}s$). Fertilizer response functions can be represented by mathematical expressions and curves and are directly affected by the use of variable inputs (X2....Xn), fixed factors (Z1....Zn), and climatic variables (W1....Wj), and indirectly by economic and social variables (E1....Eq) that influence the use of variable inputs and fixed factors. All these factors and variables are in fact modifiers of the shape or shifters of fertilizer response and demand curves and, therefore, potential constraints to fertilizer response and demand. In the following subsections these factors are discussed in the context of small-scale agriculture in sub-Saharan Africa.

The Demand for Agricultural Products

The demand for agricultural products and climatic and soil factors are the main determinants of the crops and cropping systems in sub-Saharan Africa. The demand for agricultural products has an important role in the determination of crop prices, the use of land, other fixed factors of production, and the profitability of fertilizers and other variable inputs. The total demand for agricultural products of a country includes the export and domestic demands for these products. In most countries of sub-Saharan Africa, however, the domestic demand is the most important component of the total demand for agricultural products (Table 3) and the majority of export crops are nonfood crops that are produced on larger farms with modern technology and fertilizers. Therefore, in micro-socio-economic research, emphasis must be given to the domestic demand for agricultural products, especially staple food crops.

An analysis of the domestic demand for agricultural products in countries of sub-Saharan Africa is beyond the scope of this paper. However, it is important to recognize that food preferences, population growth and, to a lesser extent, changes in income are the main determinants of the domestic demand for agricultural products. In recent years, per capita income has remained stagnated in most sub-Saharan countries, and the main source of the expansion in domestic demand has been the rate of rapid population growth.

Table 3. Estimates of Imports and Exports of Cereals, Rice, and Maize in Sub-Saharan African Countries, 1985

Country	Cereals		Rice		Maize	
	Imported	Exported	Imported	Exported	Imported	Exported
	(100 mt)		(10 mt)		(100 mt)	
Botswana	1,547	102	412	8	479	-
Côte d'Ivoire	5,539	608	34,225	123	5	575
Guinea	1,402	177	7,000	-	-	-
Kenya	3,647	-	56	-	2,000	177
Mauritius	1,793	4	8,341	41	110	-
Reunion	1,393	-	7,342	35	380	-
Zambia	2,399	350	960	-	1,300	-
Zimbabwe	1,529	1,891	596	-	-	1,887
All Other	83,637	1,182	211,450	167	12,197	2,661
Total	102,886	4,314	270,382	374	16,471	5,300

Calculations are based on 47 sub-Saharan countries.

Source: FAO Trade Yearbook, 1986.

Food preferences in sub-Saharan Africa are by and large induced by supply, that is, determined by the food crops traditionally grown in the diverse agroclimatic conditions of the region. Thus, food preferences as well as cropping patterns vary as a consequence of the diversity in agroclimatic conditions. However, as shown in Table 4, there are also distinct rural-urban differences in food consumption which may be associated with differences in food preferences, income, and the access to imported supplies of food. For instance, the increasing urban demand for rice in Liberia, Sierra Leone, and some areas of Ghana dramatically increased the importation of rice during the period 1970-80 (Pearson et al., 1981).

Changes in the demand for particular crops affect the adoption and use of fertilizers through the impact that such changes have on (1) the prices that farmers receive for their crops and (2) the provision of accessible and stable markets for the sale of surplus crop production.

The prices that farmers receive for their products affect agricultural production through their influence on (1) the land area that farmers plant with crops and (2) the use of fertilizer and other variable inputs on the areas planted. Thus, lower crop prices tend to reduce crop production as a result of the negative impact on both the area planted with crops and crop yields. Lower crop prices decrease the profitability of fertilizer use by reducing the economic value of the increments in crop yields associated with the use of fertilizers. Hence, increases or decreases in crop prices can expand or constrain the farm-level demand for fertilizers by increasing or decreasing the profitability of fertilizers and the land area planted with crops. Policies of crop support prices are often adopted to promote crop production by providing farmers with minimum crop prices and a more stable and predictable price environment.

Table 4. **Principal Food Staples in Rural and Urban Areas for 40 African Countries**

Country	Staple Foods: Rural	Staple Foods: Urban
Sahel		
Cape Verde	Maize	Maize
Chad	Millet, sorghum	Rice, wheat
The Gambia	Rice	Rice
Mali	Millet, rice, sorghum	Rice, wheat
Mauritania	Millet, sorghum	Rice, wheat
Niger	Millet, sorghum	Rice, wheat
Senegal	Millet, rice	Rice, wheat
Upper Volta	Millet, sorghum	Rice, wheat
West Africa		
Benin	Maize, millet	Rice, wheat
Cameroon	Maize, millet	Maize, millet
Côte d'Ivoire	Cassava, millet	Cassava, rice, wheat
Ghana	Maize, cassava	Maize, cassava, wheat
Guinea	Rice, cassava	Rice
Guinea-Bissau	Rice, cassava	Rice, cassava
Liberia	Rice	Rice, cassava
Nigeria	Rice, maize, sorghum	Rice, cassava, wheat
Sierra Leone	Rice	Rice, wheat
Togo	Rice, maize, millet,	Rice, wheat, cassava
Central Africa		
Angola	Cassava, maize	Cassava, wheat
Central African Republic	Sorghum, maize, cassava	Wheat, rice
Congo	Cassava, rice, maize	Wheat, rice
Gabon	Cassava, plantains	Wheat, rice
Zaire	Cassava, maize, wheat	Cassava, maize, wheat
East Africa		
Burundi	Maize, sweet potatoes, cassava, plantains, pulses	Cassava, sweet potatoes, pulses, plantains
Ethiopia	Teff, maize, barley, sorghum, wheat	Teff, maize, barley, sorghum, wheat
Kenya	Maize	Wheat, maize
Rwanda	Plantains, pulses, maize, sweet potatoes	Plantains, pulses, sweet potatoes
Somalia	Maize, sorghum	Maize
Sudan	Sorghum, wheat	Sorghum, wheat
Tanzania	Maize, rice, cassava	Wheat, maize, rice
Uganda	Plantains, pulses, millet, maize, sweet potatoes, cassava	Plantains, pulses, millet, maize, sweet potatoes
Southern Africa		
Botswana	Maize, sorghum	Maize
Lesotho	Maize, wheat	Maize, wheat
Madagascar	Rice	Rice
Malawi	Maize	Maize
Mozambique	Cassava, maize, wheat, rice	Cassava, wheat, rice
Namibia	Mahangu	Maize
Swaziland	Maize	Maize
Zambia	Maize	Maize
Zimbabwe	Maize	Maize

Source: U.S. Department of Agriculture, 1980.

Prices that farmers actually receive for their crops are seriously affected by the frequent lack of accessible and stable local markets in sub-Saharan Africa. The access of farmers to markets is often hampered by the lack of an adequate transportation infrastructure and by high handling and transaction costs. This problem and the instability of crop prices, caused by drastic seasonal fluctuations, have motivated many farmers to be self-sufficient and continue practices appropriate to subsistence agriculture. The instability of local markets for farm products has been recognized as a critical problem in promoting the transition from subsistence to commercial agriculture (Whetham and Currie, 1967). This problem is becoming more evident as planners and policymakers attempt to satisfy the increased demand for food by the rapidly growing sub-Saharan urban centers through increased supplies from local farmers.

Sub-Saharan farmers are essentially price takers and are frequently subject to collusion by traders. These characteristics of local markets, farmers, and traders have motivated many sub-Saharan governments to intervene in food marketing and attempt to ensure a predictable and stable supply of food to urban areas (Eicher and Baker, 1982). In this context, effective government policies must provide price stability for crops and improve the access of farmers to competitive markets.

In relation to crop prices and access to markets by farmers, micro-socio-economic research on farm-level constraints to fertilizer use must document (1) the influence of the prices that farmers receive for their crops on the demand for fertilizers, (2) the problems and costs of farmers in the marketing and sale of farm products, and (3) the disposal and use of crop output including main products and valuable byproducts by farmers. Here, it is important to document the views of farmers about the economic, social, and intrinsic value of the increased crop yields that fertilizers can provide.

Climatic and Soil Factors

Knowledge about climatic conditions and soil characteristics in various geographic regions of sub-Saharan Africa is crucial for understanding farming systems and agricultural production. An idea of the diversity in climatic conditions and soil characteristics that exist in sub-Saharan Africa is provided by the six agroecological zones shown in Figure 2. However, even within each zone, where micro research on farm-level constraints to fertilizer use may be conducted, significant differences in climatic and soil factors can be observed.

Climatic factors (rainfall patterns, solar radiation, and temperature) and soil characteristics (land gradient, soil texture, organic matter content, and plant nutrients) are crucial determinants of the agronomic effectiveness of fertilizer use on crop production. Climatic and soil factors can be important constraints to fertilizer use through their influence on the response of crop production to fertilizer use. These factors, therefore, must be considered as sources of classification or stratification that may be used to (1) identify relatively homogeneous domains for selecting relevant locations to conduct micro-socio-economic research and (2) minimize variability in these factors among samples of farmers selected for interviewing.

In relation to micro-socio-economic research and policy development, it is important to note two basic differences between climatic and soil factors. Climatic factors are stochastic and obviously cannot be changed through policies, whereas soil factors are given and fixed in the short-run but can be changed in the long-run through policies that promote changes in cropping systems, soils management, and the use of inputs such as fertilizers, organic manures, and lime. In reference to climatic and soil factors, micro-socio-economic research should provide information about farmers' perceptions of (1) the influence of uncertain climatic variables, such as rainfall, on crop production and fertilizer use and (2) the most important soil-related variables affecting crop management practices and the use of fertilizers.

Irrigation

The availability of irrigation is an important source of expansion of agricultural production and land productivity. In Asia, irrigation, in conjunction with the introduction of high-yielding varieties (HYV) of rice and wheat and the use of fertilizers, has been responsible for most of the increases in agricultural production and productivity in recent decades. However, in sub-Saharan Africa, the contribution of irrigation and fertilizer to crop production is very limited and rather insignificant in the majority of countries. With the exception of Sudan and Madagascar, the area irrigated is less that 5% of the total area cultivated in most other countries (Table 5). However, irrigation is important in certain areas of sub-Saharan Africa such as the river valleys of Zimbabwe, Somalia, Ethiopia, and Mozambique, and in parts of Mali, Senegal, and northern Nigeria (Eicher and Baker, 1982) Irrigation affects the use of land and the crops and cropping systems adopted by farmers. It also usually increases the response of crops to fertilizers and, thereby, the demand for fertilizers. In fact, irrigation shifts the fertilizer response and demand curves upward. Micro-socio-economic research should document the availability and use of irrigation by farmers and the role it plays in crop production and fertilizer use.

Cropping Systems

The diversity of agroclimatic conditions in sub-Saharan Africa is evident in the variation in cropping patterns. As a generalization, one or perhaps two food crops dominate

Source: U.S. Agency for International Development, 1987.

Figure 2. **Agro-Ecological Zones of Sub-Saharan Africa.**

each agroclimatic zone. Although priority is given to staple food crops, sub-Saharan farmers have developed a strategy of economic diversification based upon food crops, cash crops, and nonagricultural work. The amount and seasonality of annual rainfall are the prime factors determining the crops, cropping systems of a region, and the pursuit of nonagricultural work.

Sorghum and diverse varieties of millet are the most prevalent crops in sub-Saharan Africa. Sorghum cultivation is most common in sub-Saharan areas where rainfall is between 600 and 1,000 mm/year. In northern Nigeria and southeastern Niger, sorghum and millet crops account for as much as 50% of the cultivated area (Beeden et al., 1976). Where sorghum and millet are not intercropped,

farmers have been observed to grow several varieties of each crop on different household plots in the same year (Eicher and Baker, 1982).

Table 5. **Estimates of the Irrigated Agricultural Areas in 37 Sub-Saharan African Countries, 1970-85**

Country	1970	1975	1980	1985
	('000 ha)			
Benin	10	15	19	23
Botswana	6	10	14	16
Burkina Faso		6	7	8
Burundi	5	5	5	5
Cameroon	7	8	10	10
Cape Verde	2	2	2	2
Chad	7	7	7	7
Congo	1	2	3	4
Côte d'Ivoire	20	38	58	64
Ethiopia	75	92	93	94
The Gambia	20	25	32	33
Ghana	8	15	8	7
Guinea	50	64	68	70
Kenya	29	40	40	40
Liberia	2	2	4	5
Madagascar	330	490	820	1,020
Malawi	4	13	18	22
Mali	135	170	260	350
Mauritania	4	7	8	8
Mauritius	15	15	16	17
Mozambique	26	38	62	82
Namibia	6	7	8	8
Niger	4	6	12	14
Nigeria	22	160	760	1,280
Reunion	6	7	5	5
Rwanda	7	13	14	15
Senegal	110	160	170	175
Sierra Leone	6	13	15	16
Somalia	115	120	140	180
Sudan	1,750	1,565	1,600	1,700
Swaziland	47	56	58	62
Tanzania	38	52	120	140
Togo	4	6	3	2
Uganda	8	16	16	16
Zaire			7	7
Zambia	9	18	19	20
Zimbabwe	46	70	120	175
Total	2,934	3,333	4,621	5,702

Source: FAO Production Yearbook, 1986.

Although sorghum and millet will undoubtedly remain the food crops of choice among small sub-Saharan farmers, rice and wheat appear to be of growing importance throughout the subcontinent. Although Madagascar is the largest rice producer in sub-Saharan Africa, rice is also a staple food in Liberia, Sierra Leone, and some areas of Ghana. The importance of rice is related to the increasing urban demand. Wheat is the outstanding staple crop in the highlands (above 2,000 m) in Kenya, Tanzania, Lesotho, Zimbabwe, and Sudan. Wheat production is expanding rapidly in Sudan, northern Nigeria, and Zambia; wheat is grown mostly on large mechanized farms that are often supported through foreign aid and government policy (Eicher and Baker, 1982).

Maize, the staple food in much of eastern and southern Africa, is the principal food crop of Zambia, Tanzania, Malawi, and Kenya. There is evidence that maize is increasingly replacing sorghum and millet in West Africa. When compared with sorghum and millet, maize is less vulnerable to destruction by birds.

In the humid forest zones of Uganda, Tanzania, Ghana, Côte d'Ivoire, and Zaire, plantains, roots, and tubers are the main food crops, and they are often intercropped with maize or pulses. Cassava is an increasingly attractive root crop because it requires less labor compared with cereals and yams, it is viable in a wide range of agroclimatic regions, it has low soil nutrient requirements, and it is more resistant to pests. Cassava is referred to as a "famine crop" because some varieties can remain in the ground for several years without a significant reduction in quality.

Intercropping, simultaneously producing two or more crops on a field, is found in the cropping systems of several regions in sub-Saharan Africa. Intercropping has been adopted because it provides several technical and economic advantages. Those advantages include (1) nitrogen fixation by legume intercrops, (2) reduction in weeds and therefore labor, because intercrops cover the ground, and (3) greater plant density, fewer disease and insect problems, and better use of limited areas of high-quality soil with some intercrops compared with sole crops (Eicher and Baker, 1982). Because of these advantages, it has been estimated that the average return per hectare of intercropping is 35% higher than with sole cropping (Norman, 1974). Further evidence for that observation continued into this decade in several studies of northern Nigeria (Baker, 1978-80).

The practice of intercropping affects the efficiency of use of applied nutrients and thereby the response of crop production to fertilizers (Oelsligle et al., 1976). Hence, it is an important determinant of the farm-level demand for fertilizers. Micro-socio-economic research should provide information about (1) the intercropping practices and cropping systems that are adopted by farmers and the factors that motivate and promote their adoption and (2) the

influence of intercropping practices and cropping systems on the farmers' demand for fertilizers. This research should facilitate the identification of variables that could be modified through government policies to promote the adoption of more effective cropping systems and the demand for fertilizers.

Land Tenure

Land tenure systems affect the economic benefits and incentives for farmers to use fertilizers and other variable inputs. Land property rights and tenure arrangements that promote the unequitable sharing by farmers in the costs and benefits of fertilizer and other variable inputs and/or limit the access of farmers to the long-term benefits of inputs reduce the economic incentives of farmers to use modern agricultural inputs.

Land tenure in sub-Saharan Africa may be described as a communal system of ownership and private use rights. Access to land is often controlled by village chiefs or traditional authority figures who frequently determine descent rights. Private use rights provide households continued use of land over time and sometimes allow land to be purchased and sold. However, the commercialization of land remains limited throughout the sub-Saharan region. One notable exception is in the Buganda region of Uganda where individual ownership is well developed. Sub-Saharan farmers are frequently critical of individual ownership because that system increases the size of some farms and thereby inequality and a landless class of people. Low population densities, abundant land, and the prevention of settlers and foreign firms from acquiring land titles have limited the development of distinct landholding and landless social classes in some countries. Throughout sub-Saharan Africa, the area cultivated per household has consistently been estimated to be between 1 and 4 ha (Upton, 1973; Cleave, 1974).

As the year 2000 approaches, population growth, land pressure, expected commercialization of land, access to land by small farmers, river basin development, and more sedentary populations will require that increased attention be given to land tenure issues, problems, and policies.

The issue of sub-Saharan land tenure had been eloquently summarized by Murdock (1980):

> As long as the state is ill-formed and property relations are as yet in no-man's-land between customary and contract law, a network of chiefs will remain central to the expansion of commercial agriculture. This is not just a colonial issue: it is a matter of the relationship between an underdeveloped state and economic transformation.

During the past quarter century, most studies of land tenure in sub-Saharan Africa suggested that the communal system was not so rigid as to constrain the acceleration of agricultural production. Because land is becoming less abundant, that view is no longer justified. As land becomes more intensely cultivated, the micro-socio-economic study of land tenure systems will become increasingly important. One of the major policy tasks of sub-Saharan governments is to carefully evaluate customary laws of land tenure and suggest changes that will allow sub-Saharan farmers to have the security that will accelerate capital investment in land improvement and increased productivity.

Micro-socio-economic research is needed to (1) better characterize land tenure systems, (2) improve understanding of the role of land tenure in crop production and fertilizer use, and (3) evaluate the potential impact of policy-induced changes in land tenure. The information that micro-socio-economic research can provide about land tenure systems is also needed to assess the efficiency and equity implications of various government policies affecting the agricultural sector.

Capital Assets – Equipment and Animals

Broadly defined, capital, land, and labor are the main factors of production. The capital of farmers in the form of liquid (money) and physical assets is an indication of wealth and financial capability. The availability and use of machinery, equipment, implements, and animals in agriculture affect land use farm management practices and production technology, including the use of fertilizers.

Compared with Asia, the use of machinery, equipment, and animal traction is quite limited in most countries of sub-Saharan Africa. Hand tools and simple implements are the main means of cultivation. The importance of hand tools in sub-Saharan Africa is illustrated by the situation in Kenya where it is estimated that 84% of the arable land is cultivated by hand hoes, 12% by oxen, and 4% by tractors. Such ratios appear to be common in sub-Saharan countries (Eicher and Baker, 1982).

Farm-level data about the effects of using tractors and animal traction on crop yields and fertilizer use are still inadequate in most countries of the region. Micro-socio-economic research is needed to provide this type of data and information. This will enhance the understanding of how sub-Saharan farmers allocate limited resources and will facilitate policy development.

Credit

Agricultural credit can be a powerful policy tool to promote the adoption of improved production technologies and fertilizer use where the limited financial resources of farmers are a critical constraint. Credit is not an input in agricultural production, but rather a means to relax financial constraints that hinder farmers in purchas-

ing inputs and effectively conducting agricultural production activities. Agricultural credit is often provided selectively to promote the use of certain inputs, such as seeds of new varieties or fertilizers.

Agricultural credit systems are not well developed in sub-Saharan Africa. Rural financial markets are dominated by informal lenders, merchants, traders, friends, family, and relatives. Sub-Saharan farmers rely heavily on informal credit for expenses for rituals, school fees, gifts, and other non-agricultural consumption (Miller, 1977). A study of rural finance in Niger verified the role and importance of informal lenders (Ohio State University, 1987). This study also showed that small farmers who seek institutional loans are limited by means of transportation (Table 6) and that the vast majority of small borrowers rely on foot transportation throughout the loan processes of negotiation, disbursement, and repayment.

Table 6. **Institutional Credit, Relative Importance of Common Means of Transportation for Individual Borrowers When Traveling to Other Places at Different Stages of the Loan Process**

Means of Transportation	Stage of Loan Process		
	Negotiation	Disbursement	Repayment
	(%)		
On foot	64.0	58.0	75.0
Camel, donkey, horse	12.0	12.4	5.0
"Taxi de brousse"	16.0	16.1	15.0
Other	8.0	13.5	5.0
Total	100.0	100.0	100.0

Source: Ohio State University, 1987.

Small farmers are particularly dependent on informal loans to purchase inputs, and interest is often high. The unusually high interest rates are explained by a premium to cover the risks of the lender and greater administration costs for loans to small borrowers (Adams, 1978).

Because they are willing to extend credit on short notice, require minimum collateral, and have few restrictions on uses of the loan, informal lenders will continue to have a major role in rural finance in sub-Saharan Africa. An important advantage of informal village-level borrowing is that the logistical problems of borrowing from formal lending sources are avoided. The challenge to sub-Saharan governments is to determine how to incorporate the beneficial features of informal lending into effective formal credit programs (Ohio State University, 1987).

In response to the problems of agricultural credit for small farmers, many sub-Saharan governments have established national agricultural banks or comparable credit institutions. Low rates of loan repayment have caused some institutions to cease operations while others operate nominally and survive on subsidies. One recent study suggested that low rates of repayment reflect a widely held belief among small farmers that government loans are gifts (Tapsoba, 1981).

In general, agricultural credit institutions in sub-Saharan Africa continue to experience such problems as high administrative costs, poor coordination, inadequate funds, and poorly trained personnel (Von Pischke, 1980; Due, 1980).

The Supply of Variable Inputs Other Than Fertilizers

The farm-level agronomic effectiveness of fertilizer and thus fertilizer demand are also affected by the availability, use, and management of other variable inputs by farmers. Labor, organic fertilizers and manures, pesticides, and seeds of certain crop varieties are important variable inputs. Micro-socio-economic research is needed to document the availability, cost, use, and management of these inputs in the various agroclimatic and socio-economic environments of sub-Saharan Africa.

1. Labor

The labor provided by household family members in sub-Saharan Africa is the most important component of the use of labor by small farmers. Thus, the size of rural households in sub-Saharan Africa is a critical factor in the availability of labor for agricultural work. Studies have shown that farmers with a large number of household members cultivate more land than those whose households are small in number (Eicher and Baker, 1982).

Throughout the subcontinent, the supply of labor for specific agricultural tasks is mediated by sex and age. The agricultural work roles of women and children vary greatly by cultural group, ecological zone, and major crops. The division of labor by age and sex does not, however, appear to be a constraint on agricultural productivity. Micro-socio-economic research is needed to provide information about the influence of these variables on the farm-level availability and use of labor.

The hiring of labor is often limited, and in most cases it does not appear to eliminate seasonal shortages. The number of landless laborers in most sub-Saharan countries is minimal, and those seeking to hire labor must rely on other farmers or seasonal migrants. Because all farmers in a given agroclimatic area simultaneously reach peak labor demand, small farmers are at a distinct disadvantage in competing with larger farmers to attract labor. Because of these problems, farmers in sub-Saharan Africa generally hire less labor compared with other regions of the world (Eicher and Baker, 1982).

These observations have been documented in several studies showing that hired labor among small sub-Saharan farmers represents less than 20% of the total farm labor (Norman, 1972; Spencer and Byerlee, 1976; Byerlee, 1979). In sub-Saharan Africa, migration plays an important role in the supply, cost, and use of farm labor and in the incomes and cash flows of households. Thus, research attention should be given to generating reliable data on migration patterns (Eicher and Baker, 1982).

In summarizing the situation of agricultural labor in sub-Saharan Africa, several generalizations are possible. First, there is an active and flexible rural labor market that is responsive to wage incentives. Secondly, there is no evidence of disguised unemployment, and finally, the marginal product of agricultural labor in sub-Saharan Africa is low but positive (Eicher and Baker, 1982).

In the future, micro-socio-economic research in sub-Saharan Africa should provide information that can be used to (1) identify factors that contribute to low labor productivity in agriculture, (2) identify methods to generate employment and income during the dry season, (3) explore strategies to ease seasonal labor shortages through capital-labor substitution, and (4) guide agronomic research toward the development of production technology packages that are more suitable to the labor supply situations. These kinds of data should facilitate the development of more effective government policies.

2. **Organic Fertilizers and Manures**

Organic fertilizers and manures are important sources of plant nutrients, and they improve the physical properties of soils. By tradition, farmers have used organic manures as means of maintaining soil fertility and increasing crop production. There is ample evidence about the contribution of organic manures in increasing soil fertility and crop production. However, the basic constraints to the use of organic fertilizers and manures are the limited supplies, high transportation costs, and cultural attitudes about handling animal waste.

Few sub-Saharan farmers have access to sufficient supplies of organic manures to maintain continuous cultivation and soil fertility (Lombin and Abdullahi, 1977). The lack of adequate supplies of organic manures is explained in part by the fact that small farmers own few animals. This further explains why farmers throughout the subcontinent primarily use organic manures on food and cash crops grown very near households (Lassiter, 1981).

There has been a paucity of research on how organic manures affect agricultural production and productivity under the condition of continuous cultivation (Eicher and Baker, 1982). However, research has shown that greater increases in crop yields are obtained when organic manures are used in conjunction with chemical fertilizers than when only one source is used (Sedago, 1985). Recent evidence from western Niger suggests that farmers do not abandon organic manures when chemical fertilizers are used (Thompson and Baanante, 1988). Thus, organic manures and chemical fertilizers appear to behave more as complementary inputs than as substitutes. Micro-socio-economic research is needed to document the farm-level availability and use of organic fertilizers and manures as well as their impact on crop yields and fertilizer demand.

3. **Pesticides**

The use of pesticides is of critical importance for some crops and agroclimatic conditions and can significantly influence the effectiveness of fertilizers on crop yields. Pesticides are used mainly on cash crops in sub-Saharan Africa and are rarely used by those engaged in subsistence agriculture. Cameroon, Côte d'Ivoire, Ghana, Kenya, Nigeria, Sudan, Tanzania, and Zimbabwe are the greatest users of pesticides, but their combined imports amounted to approximately US $200,000 in 1986. Nine sub-Saharan countries decreased the importation of pesticides between 1981 and 1986, and the majority of other countries showed very minimal increases during that period (FAO, 1986).

The use of pesticides may not be important in all agroclimatic environments. However, micro-socio-economic research should document the use of pesticides and the perceptions of pests by small farmers. Indigenous and traditional methods of pest control and the willingness of farmers to adopt modern methods of control should also be documented.

4. **Improved Crop Varieties**

The development and adoption of improved crop varieties can significantly change crop production and fertilizer demand. In Asia, the introduction and widespread adoption of improved varieties of rice and wheat, which are more responsive to fertilizers than traditional varieties, have significantly increased yields and fertilizer demand. Thus, policies that are established to promote the use of particular crop varieties also affect the demand for fertilizers. In this context, micro-socio-economic research is needed to provide information about (1) the use of and preferences for various crop varieties and (2) the factors that affect and determine the preferences of farmers. Only an overview of the status of improved varieties for the main crops of sub-Saharan Africa is presented in this paper.

Sorghum and Millet – As previously mentioned, millet and sorghum are the dominant food crops in the semiarid tropical regions of Africa, and therefore research on these important crops is critical. Because research for the

genetic improvement of millet has produced rather discouraging results, more research attention has been given to the development of improved varieties of other food crops such as sorghum, maize, rice, cowpeas, cassava, and yams (Leakey and Wells, 1977).

The genetic improvement of sorghum offers an excellent example of the importance of socioeconomic factors in the process of identification, testing, multiplication, and adoption of improved varieties. Sorghum varieties with long stalks are overwhelmingly favored by farmers because the stalks are used for building houses and fences and are also used for animal fodder during the dry season. But local varieties of long-stalk sorghum have low grain-yield potential (Arrivets, 1976). The challenge for breeders is to produce long-stalk and high-yielding varieties of sorghum that are socially and economically acceptable to sub-Saharan farmers and therefore attractive enough to accelerate adoption.

Although some improved hybrid varieties of millet and sorghum in sub-Saharan countries have shown high yields at experiment stations, the performance under farm-level conditions has been less than desired. The dilemma may be stated as follows: If farmers plant short-season hybrid sorghum varieties early in the rainy season, as is customary with local varieties, the hybrid varieties are damaged by head mold because the grain matures before the end of the rainy season. But if farmers wait to plant short-season varieties, less time is available for planting cash crops and risks are increased that the crop will fail if the rainy season is short (Eicher and Baker, 1982).

Maize—The research to improve varieties of maize, the major food staple in the temperate regions of Africa, has been promising. Attention has been given to developing open-pollinated varieties, composites, and hybrids. The development of hybrids for high-rainfall areas and composites for medium- and low-rainfall areas has been extremely successful and widely applied (Heyer and Waweru, 1976).

Rice—While improved cultivars of rice have a demonstrated yield potential of 3-6 tonnes/ha, rice yields in sub-Saharan Africa are rather low. Recent estimates suggest yields of about 1,000 kg/ha for flooded rice, 500-800 kg/ha (Chabrolin, 1977) for upland rice, and only about 500 kg/ha of paddy in East Africa (Acland, 1971). Pests and diseases are a major problem in the development of improved rice varieties. The problem is illustrated by new strains of blast that occur as quickly as scientists develop varieties that are resistant to old strains. Disease-resistant cultivars have been developed but show low yield ceilings and poor quality grain (Eicher and Baker, 1982). Thus, the identification and dissemination of improved rice cultivars in sub-Saharan Africa remains a problem.

Legumes—Cowpeas are an important food crop in sub-Saharan Africa, but yields are low. The principal objectives of cowpea research are to develop varieties that combine the characteristics of stable yields, and resistance to pests, disease, and drought stress. Cowpeas are being tested as intercrops and sole crops in several West African countries. Insect damage is a major problem in sole-cropped cowpeas, but yields of local and traditional varieties may be substantially increased through the proper use of pesticides (Hays and Raheja, 1977).

Root Crops—Root crops in sub-Saharan Africa have been a relatively neglected topic of research on the development of improved varieties, but they have a great potential for improvement (Terry et al., 1981). Considering that yams can produce more protein per unit of area and cassava more energy per unit of labor than rice, research on these crops should be accelerated during the 1990s (Eicher and Baker, 1982).

Farmers' Knowledge and Access to Information

The contribution of formal education to economic and agricultural development is universally recognized. The widespread development, understanding, and adoption of agricultural technology depend on improved literacy. Literacy facilitates access of farmers to information, the learning process, and the adoption of improved agricultural technology. In most instances, the lack of knowledge and access to information is the most important constraint to the adoption of new agricultural technology.

Despite the efforts of governments, the primary school enrollment of youth aged 6-10 years varies greatly in sub-Saharan Africa, and literacy rates remain generally low. Recent data suggest that only The Congo, Zaire, Zambia, and Zimbabwe have primary school enrollments above 90%, and at least 15 countries have enrollments below 50%. Rates of illiteracy are also high in sub-Saharan countries; at least 40 countries have literacy rates of less than 50% (USDS, 1980).

The problems of education in sub-Saharan Africa have contributed to a shortage of middle- and high-level manpower that is a constraint on development. The problem of access to information and knowledge is very evident among illiterate small farmers and is frequently exacerbated by the lack of a written language. Despite apparent public support for basic education, university education is often favored in funding. Only The Congo had more than 3% of the population aged 20-24 years enrolled in higher education in 1982. These characteristics have consequences for the dissemination of agricultural information among sub-Saharan farmers.

Micro-socio-economic research should provide and evaluate information about (1) the education of the

farmers and family members, (2) the sources and means of information that is available and used by farmers, (3) the problems farmers have in the access to information and knowledge, and (4) the farmers' perceptions about the "value" of information from various sources. These kinds of data are needed for two main purposes: (1) to determine the importance of the knowledge, education, and access to information of farmers as constraints to agricultural production and fertilizer use and (2) for the development of policies to improve education programs of rural populations, extension services, and the role of organizations that are sources of information for farmers, such as cooperatives and fertilizer dealers. In the context of access to information and knowledge by farmers, micro-socio-economic research in sub-Saharan Africa should give special consideration to the role of two important sources of information – agricultural extension services and cooperatives.

Agricultural Extension Services

In countries where the extension services are the sole or main sources of agricultural information for farmers, effective communication between farmers and extension agents, is critical for the demonstration, acceptance, and use of modern agricultural technology. In this respect, some of the consequences of illiteracy in sub-Saharan Africa can be identified through micro-socio-economic research when the relationship between extension personnel and farmers is evaluated.

Beyond the problem of illiteracy, extension work in sub-Saharan Africa has been plagued by numerous problems that include too few agents in some countries, low wages, poor training and support, ineffective linkages with research centers, low social status, inadequate funding, and poor transportation support (Eicher and Baker, 1982). These characteristics have hampered the effectiveness of extension services in providing agricultural information to farmers.

The ability of extension agents to provide farmers with agricultural advice is also hampered by the reputation of extension agents during the colonial period, when agents often collected taxes, recruited involuntary labor, and enforced land conservation and certain rules and prohibitions in growing certain crops. These activities have created a legacy of skepticism and distrust that continues to influence contemporary extension programs and the dissemination of knowledge and information among sub-Saharan farmers.

Agricultural Cooperatives

Agricultural cooperatives may also serve as a source of information for farmers, but the record of cooperatives in sub-Saharan Africa is mixed. At least in the case of West Africa, farmers are often jaded in their attitude toward cooperatives and are not usually impressed with the services or benefits (Thompson and Baanante, 1988; Hart, 1982). With the exception of those cooperatives involved in cash crops such as tea, cotton, and tobacco, the record of most cooperatives has been disappointing. Although there are numerous explanations for the shortcomings and failures of sub-Saharan cooperatives, the shortage of skilled managerial and administrative talent, which depends on basic education, is perhaps the most important.

In sub-Saharan Africa, the problems of basic education and agricultural infrastructure have an important effect on the ability of extension agents and cooperatives to offer agricultural information and the ability of farmers to receive and understand that information. The consequences of these factors are such that farmers often receive poor information, incoherent information, or perhaps none at all. In this situation, resolute policy changes are clearly needed to bolster and strengthen the availability of and access to information among small farmers. The shortage of skilled manpower will only be reversed by sound policy planning and an increased emphasis on basic education.

Supply Constraints

The use of fertilizers by farmers depends not only on their demand for fertilizers but also on the availability and cost of fertilizers. Often fertilizers are not used because of constraints in the supply of fertilizers, inadequate availability, and/or high costs, rather than as a result of constraints to the farmers' demand for fertilizers. In micro-socio-economic research and policy development, it is important to distinguish between these two sets of constraints to fertilizer use.

Fertilizer supply constraints are associated with the production, importation, distribution, and pricing of fertilizers. Infrastructure development and policies that affect these aspects of the supply of fertilizers are the main sources of potential constraints to fertilizer supply. Micro-socio-economic research on farm-level constraints to fertilizer use must identify the constraints to fertilizer supply in the area or region where the research is conducted and document the farmers' access to fertilizer supplies.

Production and Imports

For the period 1980-85, FAO data show that fertilizer production of NPK in sub-Saharan Africa is limited to the countries shown in Table 7. The leading producers are Zimbabwe, Senegal, and Tanzania. Because of the limited capacity for production of NPK products, sub-Saharan Africa is heavily dependent on imports as shown by FAO data presented in Table 8. Careful attention, therefore, must be afforded to the problems associated with the

importation of fertilizers, such as port facilities, handling costs, storage, transportation, and retailing, as well as regulatory policies. Special attention must be given to the ability of landlocked countries to import fertilizers.

Table 7. **Estimates of Total Fertilizer Production in 11 Sub-Saharan African Countries, 1980-85, N + P_2O_5 + K_2O**

Country	1980	1981	1982	1983	1984	1985
	('000 tonnes)					
Cameroon		9				
Cote d'Ivoire	9	5	6	6	4	5
Mauritius	9	8	8	9	8	9
Mozambique	7	5	3	1		
Nigeria	5	10	7	4	5	5
Senegal	31	30	19	34	40	50
Somalia					2	9
Swaziland	2	3		5		
Tanzania	16	19	3	9	7	14
Zambia	6	5	7	6	5	2
Zimbabwe	114	110	122	116	108	111
Total	199	204	180	190	179	205

Source: FAO Fertilizer Yearbook, 1986.

Distribution

Fourteen sub-Saharan countries have no direct access to the sea, and as shown in Figure 3, the areas within 500 km of ports are limited to only a fraction of the land area comprising the subcontinent. The land transportation systems within and between sub-Saharan countries are a constraint to the distribution of fertilizer products and remain a lingering problem of infrastructure development. The transportation and distribution costs increase the price of fertilizer at the farm-level and, thereby, the economic incentive for farmers to adopt and use fertilizers. Data from selected countries shown in Table 9 indicate that the distribution costs of fertilizers are indeed substantial.

The sub-Saharan transportation network is an important constraint to the distribution of fertilizer and other agricultural inputs. Although transportation by animal and foot is being slowly replaced by motorized vehicles, serious transportation problems remain in the Sahelian region in general and in Mali, Niger, Chad, and Mauritania in particular (Grolleaud and Kohler, 1979). Those problems are particularly acute during the rainy season when the availability of inputs is critical.

Table 8. **Estimates of Total Fertilizer Imports Among 40 Sub-Saharan African Countries, 1980-85, N + P_2O_5 + K_2O**

Country	1980	1981	1982	1983	1984	1985
	('000 tonnes)					
Angola	17	12	5	10	7	20
Benin	1	3	3	5	7	9
Botswana	1	1	2	1	1	1
Burkina Faso	5	10	10	13	12	11
Burundi	1	1	1	3	2	2
Cameroon	44	26	40	44	49	67
Central African Republic	1	1	1		1	3
Chad	1	5	5	6	7	7
Congo	1	1	2	2	3	5
Cote d'Ivoire	45	48	41	53	60	61
Ethiopia	50	6	36	60	36	79
Gabon		2		2	2	3
The Gambia	2	1	2	2	2	6
Ghana	12	47	9	21	9	12
Kenya	62	83	69	87	79	100
Guinea		1	1			
Guinea Bissau		2	1	1		
Lesotho	5	5	5	5	5	4
Liberia	3	5	1	3	1	4
Madagascar	9	7	16	14	7	10
Malawi	33	34	32	43	58	22
Mali	17	13	6	15	23	27
Mauritania					1	2
Mauritius	17	18	21	22	22	20
Mozambique	20	39	37	14	12	3
Niger	3	6	3	2	2	4
Nigeria	177	204	195	260	272	420
Reunion	4	15	9	17	7	14
Rwanda			1	1	2	1
Senegal	16	16	6	14	17	21
Sierra Leone	2	3		1	1	4
Somalia	2		1	2	2	1
Sudan	81	83	69	41	55	93
Swaziland	18	14	10	12	9	8
Tanzania	20	17	25	17	26	25
Togo	3	4	3	1	7	13
Uganda	1	1			1	
Zaire	8	8	7	9	12	7
Zambia	69	64	94	50	32	10
Zimbabwe	56	72	85	43	38	52
Total	807	878	854	896	890	1,151

Source: FAO Fertilizer Yearbook, 1986.

Figure 3. **Areas Within 500 km of African Ports.**

Data from Nigeria further illustrate the problems of the distribution and availability of fertilizers. As shown in Table 16, the mean walking radius of a fertilizer store is 19.5 km which, given severe transportation constraints, is substantial.

Sub-Saharan markets appear to operate under conditions of (1) high transaction costs; (2) high handling costs; (3) inadequate transportation infrastructure; (4) weak food supplies due to weather, disease, and storage loss; and (5) lack of product homogeneity. These problems are well summarized by The World Bank statement that "the central problem in marketing and input supply is the very general tendency to give too large a set of responsibilities to public sector institution, and too few to other agents (such as) individual traders, private companies, and farmers' cooperatives" (World Bank, 1981).

Methodological Issues

During the last 25 years, micro-socio-economic research among small farmers in sub-Saharan Africa has been typically conducted through case studies, longitudinal surveys conducted periodically throughout one cropping season, and exploratory surveys.

Table 9. **Fertilizer Physical Distribution Costs in Six Sub-Saharan Countries**

Country	Costs (US $/tonne)
The Gambia	41.50
Kenya	133.33
Nigeria	136.97
Sierra Leone	149.31
Sudan	166.73
Tanzania	238.50

Source: Trupke, H. 1983.

Table 10. **The Distribution of Fertilizer Stores and Storage Capacity by State in Nigeria, 1979**

State	Land Area (km^2)	Number of Fertilizer Stores	Total Storage Capacity ('000 tonnes)	Walking Radius of a Fertilizer Store (km)
Borno	116,206	57	35.00	25.5
Sokoto	102,496	163	41.00	14.1
Gongola	91,493	30	41.25	31.2
Kaduna	70,215	204	57.00	10.5
Kwara	66,843	58	40.00	19.1
Niger	65,012	29	23.50	26.7
Bauchi	64,000	94	26.50	19.4
Plateau	58,008	35	30.00	23.0
Benue	45,187	36	25.80	20.0
Kano	43,268	114	56.31	11.0
Bendel	37,687	14	10.40	29.3
Oyo	37,671	26	26.00	21.5
Cross River	27,037	11	9.60	28.0
Ondo	20,951	46	13.50	12.0
Rivers	19,346	15	4.00	20.3
Anambra	17,776	22	11.80	16.0
Ogun	16,756	13	9.50	20.3
Imo	12,205	28	13.00	11.8
Lagos	3,344	8	4.00	11.5
				$\bar{X}$19.5

Source: These figures are derived from data from the Ministries of Agriculture and Natural Resources of the states. Cited in *Food Policy Issues and Concerns in Sub-Saharan Africa*, International Food Policy Research Institute, 1981.

Case Studies

Case studies, sometimes called the model farm approach, provide rich and detailed descriptive information. However, case studies provide only a limited basis for empirical generalization and are therefore limited in scope. The prevalence of case studies conducted by anglophone rural sociologists and agricultural economists declined during the 1960s and 1970s.

Longitudinal Surveys

Following the decline of the case study approach, research became increasingly based upon surveys, random sampling, and the longitudinal design, sometimes called the multiple-visit approach. Multiple-visit surveys have provided reliable data on agricultural production practices of small farmers but are rather expensive. Interviewing the same farmer several times during one cropping season is logistically difficult and costly. Also, it is a problem to maintain the interest of farmers when they are frequently interviewed. Another disadvantage of these surveys is that the planning, execution, and publication of results require 2 or 3 years. During the past 10 years, researchers have sought designs that can produce results in a few months rather than years.

Exploratory Surveys

By the early 1980s, farm-level research in sub-Saharan Africa was increasingly characterized by what are called exploratory or informal surveys. In this approach, farm-level interviews are conducted once or a few times to collect an inventory of data and information on current practices, and special attention is given to micro-socio-economic aspects. This approach is less expensive, and results can be published in a shorter period of time than in the case of longitudinal surveys. Exploratory surveys have considerable promise as a tool for conducting micro-socio-economic research to study farm-level constraints to agricultural production and fertilizer use.

Issues of Survey Design

Survey designs for use in sub-Saharan Africa must from the outset take into account that most farmers are illiterate, do not keep agricultural record books, are often indifferent to quantification, and frequently do not express the sizes of their fields in hectares or acres. These characteristics require that respondents call upon fallible memories and offer reasoned estimates of labor, production, and costs.

The design of any survey ultimately affects the survey results. There are numerous issues regarding the relationships among the specific objectives of micro-socio-economic research; the survey design, the results, and some particularly important issues are discussed here.

1. **Selection of Sampling Frame**

It is not usually necessary to collect data from every farmer in a village or region in order to draw conclusions about the population of farmers in whole villages or regions. A sample of farmers can be selected to ensure that those interviewed are representative of the larger population. The sampling frame and techniques that are adopted to select a sample of farmers that is representative of the population of farmers in the region where micro research is conducted depend on the sources and magnitude of variation in the population of farmers. Usually, the more variation there is in the population being studied, the larger the sample required to adequately represent the population.

Proper identification of the population of farmers being studied is a prerequisite for the design of an efficient sampling frame. An efficient sampling frame should allow the selection of a representative sample of farmers at the least possible cost in conducting the survey.

2. **Design of Questionnaires**

Depending on the objectives of the micro-socio-economic research and the type of survey, different types of questionnaires are designed to collect data and information from farmers. In order to design and prepare preliminary questionnaires, basic information on agricultural production practices and farm structure in the region to be studied must be obtained. The procedures that are used for gathering this information, testing the preliminary questionnaire, and preparing the final questionnaire are critical to the success of micro-socio-economic research. To accomplish these tasks, the researcher must rely on secondary sources of information, discussions with persons who have field experience in the region to be studied, and interviews with a few farmers to field test a preliminary questionnaire. These interviews help to identify the inadequacies of preliminary questionnaires and provide new insights, which are valuable for revisions and preparation of a final questionnaire.

3. **Securing Interviewee Cooperation**

An additional benefit of short-term visits to pretest a tentative questionnaire is that the research project can be introduced and the support and cooperation of those to be interviewed can be secured. Gaining the support of village authorities is very important in sub-Saharan Africa and should never be underestimated.

4. **Interviews With Village Authorities**

It is through informal discussions with village authorities that the achievements and shortcomings of local agriculture can be documented. Information about cropping systems, the access of farmers to markets, marketing of agricultural inputs, institutions, and farm structure are important aspects to explore in these discussions. Such information is invaluable for the development of a questionnaire, recording of responses, and analysis of data. These discussions are often useful for devising alternative methods for gathering information on sensitive issues such as land and livestock holdings and use of various forms of credit. The discussions with village authorities are important for the establishment of guidelines to avoid collecting excessive and sometimes irrelevant data, which has been cited as a problem in micro-socio-economic research studies of farming in sub-Saharan Africa (Farrington, 1975; Abalu, 1980; Candler and Slade, 1981).

Data Processing

The processing of survey data has posed a major problem for agricultural researchers throughout sub-Saharan Africa. The literature shows that there has been a tendency to collect a broad range of data with attention being given to problems of analysis only after data collection is completed (Abalu, 1980). This problem has resulted in the collection of data that are never coded and analyzed and in delays of 1-3 years between data collection and the publication of research results (Eicher and Baker, 1982).

It is apparent that data processing should be understood as an integral part of the entire survey design and analysis process. Although many sub-Saharan countries maintain data processing facilities, most centers have only a limited capacity and access to hardware and software packages. The use of microcomputers will certainly increase in sub-Saharan agricultural research, and training requirements will need to be appropriately organized. This will facilitate data processing, analysis, and the execution of micro-socio-economic research.

Implementation of Micro-Socio-Economic Research

In conducting farm-level surveys, the cooperation and support of one or more national research authorities is indispensable. Representatives of government or national research institutions are in a unique position to offer observations on agriculture and fertilizer use for comparison with observations offered by village authorities and farmers. The congruence or divergence of observations is often useful and instructive. By comparing government views with those at the farm level, researchers can understand and document structural sources of cooperation, conflict, and misunderstanding.

Furthermore, and most importantly, such observations provide an invaluable basis for constructing, developing, and implementing agricultural policy. Such an approach provides a micro-macro research linkage that is often neglected. There are additional sociological considerations that must be taken into account at the farm level.

Specifically, it is essential that the goals and intentions of the research project be explained to village authorities. The demeanor and attitude of the researcher should be characterized by an interest in village life and agriculture rather than one of formal inspection and questioning supported by government. Therefore, the researcher should avoid being accompanied by officials during the initial introductory visit and subsequent field interviews with farmers. It is the responsibility of the researcher to gain the cooperation and support of village authorities. Carefully selected small and token gifts are an entirely appropriate means of accomplishing this goal. In the absence of the support of village authorities, it is unlikely that farmers will be cooperative and informative.

In conducting interviews with farmers, the initial questions should suggest that the researcher has a genuine interest in the farmer per se. Efforts should be made to cultivate an informal but detailed conversation based on the questionnaire. It is through these means that the viewpoints and concerns of farmers can ultimately be considered in policy analysis and development. The researcher should play an objective and intermediary role between government and farmers.

Implications for Policy Development

A reversal in the declining per capita food production is a prerequisite to the future development of the economies of sub-Saharan African countries. The micro-socio-economic framework for research presented in this paper offers policymakers a scheme to formulate agricultural policies that take into account the circumstances, problems, and issues that confront small-scale subsistence farmers in sub-Saharan Africa. Micro-socio-economic research can make a contribution to the creation of more reliable data and information, which are indispensable for the development and implementation of effective policies to promote agricultural development.

Micro-socio-economic research can improve the understanding of sub-Saharan agriculture from the bottom up, that is, it provides the basis for an inductive approach to policy development. Policies that are established in the absence of reliable information about the circumstances and problems of farmers, which micro-socio-economic research provides, have only a limited potential for success. The limited impact of fertilizer subsidy policies in promoting the use of fertilizers in sub-Saharan Africa is explained in part by the lack of supplementary policies to relax other farm-level constraints to fertilizer use. The effectiveness of price policies can be enhanced significantly if information about other farm-level constraints to fertilizer use and agricultural production is available.

Special attention must be given to small scale farmers in research and policy development. The central importance of small-scale farmers is well stated in the following quotation (Wortman, 1975).

> The bulk of basic food supplies of the agrarian nations are produced by the many farmers with tiny landholdings, often in remote and isolated areas, plus those people in coastal areas who depend on near-shore fisheries and aquaculture for a livelihood. For the most part, the gains in productivity and income of these rural people – the poorest of the poor – will require the development for and use by many farmers of new high-yielding, science-based crop and animal production systems tailored to the unique combination of soil, climate, biological, and economic conditions of every locality in every nation.

Also, the focus on small-scale farmers in the design of rural development policies for sub-Saharan Africa is emphasized in a recent statement of the World Bank (1981), which cites three reasons to support that approach:

1. Although it (production of small farms) accounts for the bulk of agricultural output in most countries, its massive potential has yet to be realized: use of on-farm inputs is still quite limited, yields are very low, and specialization is uncommon.
2. Recent studies confirm what most of the literature on African economics suggests – that poverty on this continent, unlike in Latin America, is still predominantly a rural phenomenon. Thus, raising the output and income of small farmers is the best way to meet basic needs.
3. Attention to small holders is a more cost effective way to raise output than other alternatives currently allow – at least for most crops and areas.

Furthermore, small-scale farmers should receive policy and research priority because, in most cases, efficiency and equity goals are more effectively achieved through research and policies that promote agricultural productivity on small farms.

The challenge for agricultural development in countries of sub-Saharan Africa throughout the 1990s and beyond is to design and implement agricultural policies that (1) are based on empirical research that provides sound information about farmers' circumstances and problems, (2) are appropriate to the millions of small producers, and (3) can be implemented with limited manpower in terms of trained agricultural scientists, administrators, and extension personnel. The implementation of the framework presented in this paper for the conduct of micro-socio-economic research will provide information that is essential for the design of effective agricultural development policies in sub-Saharan Africa.

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Stratégies en Vue d'Améliorer la Diffusion Des Informations Sur Les Engrais en Afrique Sub-Saharienne

M. Connolly et R. Coster

Résumé

Les instituts nationaux et internationaux de recherche agricole se partagent la tche de développer des technologies appropriées de production agricole et de diffuser les informations sur ce sujet auprès des services de vulgarisation et des agriculteurs d'Afrique sub-saharienne.

Les difficultés qui freinent ce processus sont les suivantes: (1) la faible productivité de la recherche, (2) l'insuffisance de fonds, (3) le manque de liens entre les services de recherche et de vulgarisation, et (4) les faiblesses des systèmes de diffusion et de transfert de technologies.

Cet exposé est centré sur le problème de la vulgarisation des informations sur les engrais et sur les moyens de mieux connaître les systèmes existants et par là d'aider le personnel local à utiliser efficacement les informations disponibles. Les principaux problèmes à résoudre dans ce domaine sont mis en relief à travers les questions suivantes:

1. Quels sont les liens qui existent entre les centres internationaux et les programmes nationaux et quelle est l'efficacité des systèmes mis en place pour la vulgarisation des informations?

2. Quelles ressources sont allouées à la diffusion des informations dans les systèmes nationaux et quelle est l'efficacité des liens de communication entre la recherche et la vulgarisation?

3. Quelles publications et quel matériel de support produisent les instituts de recherche pour le personnel de vulgarisation; quel est leur degré de pertinence et d'efficacité?

4. Quel est le niveau de la coopération entre pays dans le domaine de l'échange d'informations, et existe-t-il un espace pour des initiatives en vue de favorise: les échanges au niveau national?

5. Comment mettre à profit les nouvelles technologies pour améliorer la communication en général et la diffusion des informations dans la région?

Toute stratégie visant à améliorer la diffusion des informations dans le secteur des engrais doit inclure la mise en place de deux outils de travail indispensables: (1) un répertoire des institutions engagées dans la génération, la diffusion et l'utilisation des informations sur les engrais et (2) un inventaire des projets de recherche en cours.

A partir de là, les liens entre les centres nationaux et internationaux de recherche pourront être évalués et renforcés. Le rôle du système de réseau dans ce processus est d'une importance cruciale, de même que la formation du personnel local.

Pour répondre à ce besoin, l'IFDC-Afrique prépare une contribution clé dans le secteur des engrais, à travers la publication de la "Revue des engrais en Afrique" une revue biannuelle qui sera publiée en franais et en anglais, et qui sera centrée sur la recherche, les politiques, la commercialisation, la communication et la formation dans le secteur des engrais.

Strategies to Enhance the Dissemination of Fertilizer Information in the Sub-Saharan Region

M. Connolly and R. Coster

Introduction

As Peter Adeniyi of the University of Lagos noted in October 1987, "There is hardly any aspect of development activities where the lack of basic information on basic resources has not inhibited the development process of Africa."

International and national agricultural research institutes share the tasks of developing improved food production technologies and disseminating information to extension services and farmers in the region.

The difficulties that limit the effectiveness and impact of national and international agricultural research in sub-Saharan Africa are widely chronicled. The productivity of research has been low, especially during the past 15 years, and a multiplicity of factors constrain national agricultural development, including lack of funds, poor linkages between research and extension services, and weak systems for information dissemination and technology transfer.

The World Bank, in a review of agricultural research in West Africa (1987), points out that there is a tendency to overstate the weaknesses of national research systems in the region. It is more useful and constructive to look at the strengths of the national systems and to evaluate their impact and effectiveness in a realistic context that takes account of the stage of development of educational institutions, literacy levels among rural populations, and infrastructure and technology for communications.

Although there has been regular external analysis and review of agricultural research and technology transfer in the region, there is very little specific information on how national systems disseminate information and how their productivity and effectiveness in this area can be improved within existing resource allocations. This is especially true in relation to the information component of technology transfer, i.e., information sources and their efficiency and channels for communication among those who generate technology, those who transfer it, and farmers who adopt it.

In 1984, the governments of 18 West African countries spent US $226 million, excluding foreign aid, on agricultural research. By 1984, the total pool of national researchers in these countries had risen to 2,700 from an estimated 300 in 1970. This substantial increase in national expenditures in agricultural research has been paralleled by a comparative reduction in national expenditures in extension, especially in West Africa. Between 1970 and 1980 research expenditures have increased on average at an annual rate of 8.4%, whereas expenditures on extension have increased at an annual rate of 1.2%. Most African national systems have allocated additional resources to technology development or adoption, and international research centers have also concentrated on technology development.

There are major issues to be addressed in relation to the dissemination of agricultural information in general and fertilizer information in particular. In this paper we focus on what issues are important for fertilizer information dissemination and how, through research and training initiatives, we can increase our knowledge of existing systems and also assist personnel at national levels to harness and disseminate information more effectively.

Current Issues in Information Dissemination

Some major issues include the following:

- What are the linkages between international centers and national programs and how effective are the existing systems of information dissemination?
- What resources are national systems allocating to information dissemination and how effective are research-extension communications and linkages?
- What publications and support materials are produced by research institutes for extension personnel and how relevant and effective are they?
- What is the degree of cooperation on information sharing between countries and is there scope for initiatives to facilitate greater information exchange at national levels?
- How can new information technologies be used to improve general communications and information dissemination in the region?

One reality in Africa today is that, often, available information relating to agricultural production technologies is not transferred from international to national institutions. The strength and the efficiency of the International Agricultural Research Centers (IARCs) can assist NARS to improve their adoption capabilities through training and the introduction of modern communication systems, methods, and supports.

In addition to difficulties with research per se, there are also many problems related to effective communication with farmers. Extension services have lagged behind research in terms of both budgetary and manpower commitments. Figure 1 outlines the basic structures and systems through which international institutions disseminate information to national institutions. This outline relates predominantly to agricultural production technologies where structures and systems exist. In areas of policy, trade, and marketing in relation to fertilizers there are often no structures or systems in place, and therefore the problems related to the adoption of research results are compounded.

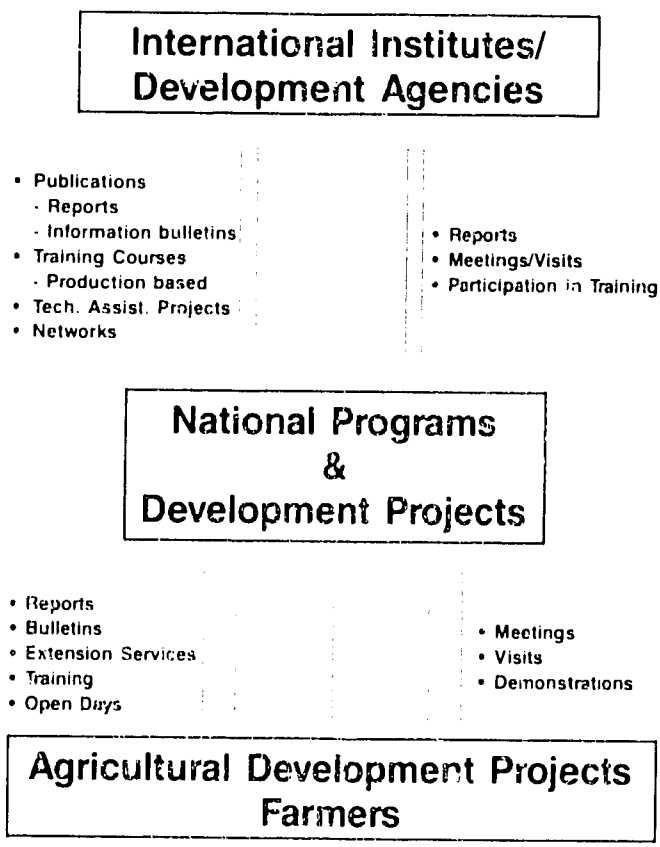

Figure 1. **Information Dissemination for Agricultural Technologies in Sub-Saharan Africa: Outline of Existing Structures/Systems.**

Very little is known about the availability of fertilizer-related information in the region, especially in relation to how it is generated, collected, and disseminated. This is true at both regional and country levels. Moreover, there has been very little interaction or cooperation between individual countries and, until now, no coherent international initiative to explore policy options and to provide the necessary stimulus and impetus for structured or coordinated development approaches. So the need to identify key national personnel and bring them together to address common problems and share experiences in exploring ways and means to overcome problems is the first crucial step toward progress.

Another important aspect is related to the benefits of existing methods and systems of information dissemination. Are the target audiences getting significant benefits from the existing channels? This requires an assessment of national information needs, identification of the clients, review of the suitability of various systems of communication, training programs, and evaluation of the impact of technology transfer.

Strategic Approaches to Improve Information Dissemination

A constructive start would be a study of the infrastructure that is currently in place to serve the fertilizer sector. This should result in a directory of institutions involved in generation, dissemination, receipt, and use of fertilizer-related information. Another closely related output would be an inventory of ongoing research projects; this would preclude any duplication of effort. Then, linkages between IARCs and NARS and among NARS can be assessed to find ways to strengthen international collaboration in the region.

One effective system is networking. Senior personnel at national levels come together to develop channels for ongoing contact and collaboration. Networks serve as central mechanisms for information exchange and engage in active and continuous methods of communications—above and beyond mere annual meetings.

As a spur to national cooperation, IFDC-Africa was instrumental in establishing and coordinating the African Fertilizer Trade and Marketing Information Network (AFTMIN) in 1987. Through various advisory, development and information services, the network aims to assist governments in the developing countries of the region to formulate appropriate policies for fertilizer procurement, marketing, and consumption; to identify and remove domestic constraints to the optimal use of fertilizer; and to promote and develop increased national and regional capacities for the efficient production of chemical fertilizer.

This network will have an important role to play in ensuring that the relevant information actually reaches key decisionmakers in the public and private sector. Without a precise, well-targeted approach for information dissemination to clients, much of the effort in data collection and analysis will bring little reward. An added advantage is that the collaborating institutions are truly involved in the process of collection and dissemination of information that is pertinent to their national fertilizer sectors. Thus, in the process, central sources of fertilizer information at national levels will be developed. Such centralized national information sources have flourished in Asia and are acknowledged to have contributed significantly to the development of the fertilizer sector in the developing countries of that region. There is also potential to use computerized databases to improve access to, and availability of, fertilizer information.

The training of national personnel is another area where international initiatives can help. It should be clear that personnel who have received no training in information or communication related to agricultural technology transfer in Africa need opportunities to develop skills for effective communication. In agriculture, for example, little communication training is included in the syllabi of diploma or degree courses. Also, although international agricultural research centers and agencies provide very good training courses in crop production technologies, these courses rarely contain modules on management or communications. The provision of training in these areas can help develop the skills of national personnel in areas that are very important for information dissemination.

Training in Extension of Fertilizer Management

At national levels there is also a need to provide training for extension personnel in fertilizer technology transfer. The accurate identification of needs at various levels is important here. International agencies cannot undertake training on the scale necessary to meet the area's requirement for trained personnel at the national level; such an endeavor would require the training of literally thousands of people. International agencies can, however, make significant and cost-effective interventions through the provision of training courses for key trainers at national levels. "Train-the Trainer" courses can develop core skills in areas such as extension communications, including techniques and methods to clearly and effectively present information about fertilizer-based food production technologies to farmers.

The poorly developed extension services in most African countries are cited frequently as a major cause of the generally low levels of transfer and adoption of improved technologies for food production. The World Bank's evaluation of agricultural research and extension projects (1985) includes three African countries – Nigeria, Mali, and Kenya – and provides a frank analysis of the problems encountered with national extension systems.

> Weaknesses in the mechanisms for communication of research results to farmers were evident, even in countries where the bank supported national extension projects. These resulted mainly from inadequate communication between research workers and extension agents. The importance of communications as an essential element in solving linkage problems was not well recognized by national agencies or, at times, by the Bank. The lack of recognition was evident from the fact that the supervision reports made no mention of the failure of research and extension training centers to utilize adequate and up-to-date equipment, mass media, and teaching methods even when these were financed by the Bank.

The bank's recommendations placed a firm emphasis on the active participation of national research organizations in "translation of research results into recommendations for users." It is accepted that, frequently, research results and information are not in a form that is comprehensible for extension personnel and farmers.

IFDC-Africa plans to implement training initiatives to improve the capabilities of national extension services to communicate fertilizer research results and associated food production technologies to farmers. The overall thrust of the extension training programs will be to provide for the integrated development of extension personnel. First, senior personnel will participate in exploratory workshops that will appraise current developments in extension throughout Anglophone and Francophone African countries. The training needs of field extension officers will be identified with specific focus on the communications skills necessary to transfer fertilizer technology to farmers. Training programs will then be prepared and implemented for field extension officers with special emphasis on methods and skills for effective extension communication.

Finally, the production of publications specifically for extension support and training at national levels is also an area that offers much potential in Africa. Computerized technologies for publication design, layout, and printing can be readily used to bring information efficiently and effectively to national programs. Both national research and extension programs can adopt and use desktop publishing technology to provide information through high-quality yet low-cost publications and media to extension personnel. IFDC-Africa plans to demonstrate the advantages of these technologies and explore ways of assisting national programs to use them effectively.

Initiatives to Improve Fertilizer Information Dissemination

IFDC-Africa also plans to publish a biannual non-refereed magazine, "Africa Fertilizer Review," in English and French to provide updates and reviews of developments in areas such as fertilizer research, policy, trade, marketing, communications, and training. National program activities will be covered, and it is envisioned that national scientists and extension officers will contribute articles and papers. The initiative should strengthen fertilizer information exchange in the region and facilitate greater communication between national and international personnel involved in fertilizer development efforts.

There is also a need to provide an authoritative reference source for information on fertilizer research to date in sub-Saharan Africa for the benefit of scientists in the region. IFDC-Africa plans to compile and publish a bibliography of fertilizer research that will identify the existing sources of scientific knowledge for Anglophone and Francophone Africa and make it available to national programs in the region. There will also be a need to publish abstracts of papers on fertilizer research, and this will be achieved through "Africa Fertilizer Review" and selective publications of abstracts as required. IFDC-Africa's initiatives and interventions in the region to improve fertilizer-based technology transfer are outlined in Figure 2.

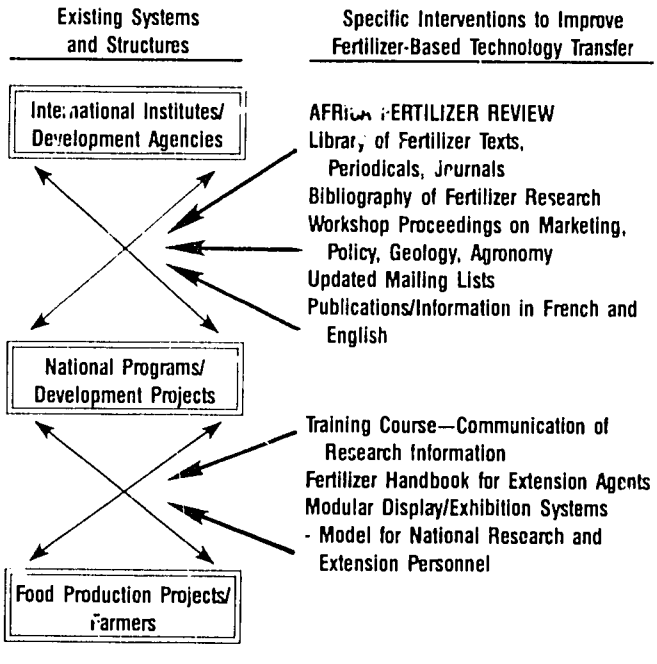

Figure 2. **Agricultural Technology Transfer and FertilizerInformation Flow in Sub-Saharan Africa – IFDC-Africa Initiatives.**

Although the initiatives described above will bring a new impetus to fertilizer information exchange and dissemination in the region, IFDC-Africa also recognizes that further research is needed to obtain more precise information about the existing infrastructure and capacities at international and national levels. IFDC-Africa will embark upon a project entitled "Infrastructure and Systems for Fertilizer Information Generation and Dissemination in Sub-Saharan Africa: An assessment and Inventory of Capacities at International and National Levels." This project should be completed in 1989.

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Part III

Panel Discussions and Summary of Recommendations

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Panel Discussions and Summary of Recommendations

Tshikala B. Tshibaka

The recommendations made by the participants at the seminar can be grouped into four categories: information, supply of fertilizers, fertilizer use, and the institutional structures.

The Information Sector

The operation of the information sector in tropical Africa has some shortcomings which explain, to a great extent, the fact that agricultural policies in general and those concerning the use of fertilizers in particular are formulated on the basis of an inadequate knowledge of the technical, economic, and institutional variables.

More precisely, this information is about all the chain of events starting with the international market and ending with the farmer, including the national institutions which deal closely or remotely with chemical fertilizers.

The understanding of the fertilizer international market is an important asset that allows the buyers to have access to good quality products at competitive prices. The foreign exchange savings which are made can be substantial. Thus, the gathering and the dissemination of such information are necessary.

The operation of the domestic network of the different countries of the region is sometimes misunderstood and wrong information can be transmitted among the research institutions, the extension services, and the different state services dealing with fertilizers. This lack of information dissemination within the country does not allow the different participants to perform efficiently.

The dissemination of the research results within the country between the researchers, the political decision makers, the analysts, the extension workers, and the farmers allows the decisionmakers to redefine their policies and the researchers to reorient their research programs.

Moreover, the education institutions have to be closely associated with this information exchange because they are involved in the education of the future political decisionmakers, researchers, extension workers, and farmers.

Information exchange on research, extension methods, institutional organization (particularly information on credit, supply, distribution, and marketing of fertilizers) must be encouraged in the region. The regional and international centers can also help in this area.

Fertilizer Supply

During our discussions it became clear that the procurement of fertilizers is not performed efficiently. Besides finding a solution to the managerial problems, a certain number of measures capable of reducing procurement, storage and distribution costs of fertilizers in our countries have to be considered.

Among these measures, we could consider importing high-grade fertilizer in bulk, processing it in the country, as well as eliminating all custom and other duties. Fertilizers, like oil products, should also be considered strategic products.

Fertilizer Use

During the seminar, a certain number of research themes on the factors influencing fertilizer use in all sub-Saharan countries were given a high priority. These research themes can be classified into two categories: (1) the study of the economic environment in which the farmer evolves and (2) the study of the agronomic and sociological aspects.

The analysis of the economic environment has to be global, including all the critical economic variables affecting the overall agricultural production system. These variables include among others: prices of agricultural products, agricultural credit, fertilizer and other input subsidies, land ownership, risk, and the decisionmaking process within the agricultural household.

At first, the overall fertilizer agronomic research effort has to analyze the reaction to fertilizers of monocultures and intercropped cultures in different ecological conditions. Second, the search for ways and means to increase the efficient use of fertilizers in tropical areas has to be pursued with more rigor. Here, the impact of the complementarity between fertilizers, the other modern production factors, and the role of the improved cultivation techniques has to be explicitly examined.

Institutional Reforms

Imports, production, distribution, and marketing of chemical fertilizers in most of the sub-Saharan countries are directly or indirectly controlled by the state. This institutional framework seems to explain, to a certain extent, the weak performance of the fertilizer subsector in several African countries. An analysis of the possibility of institutional reforms deserves to be considered. The present reform undertaken in Cameroon is an experience to think about.

Discussions De Groupe Et Résumé Des Recommandations

Tshikala B. Tshibaka

Les recommandations présentées par les participants à l'issue du séminaire peuvent être résumées sous trois rubriques à savoir : l'information, l'approvisionnement en engrais, l'environnement économique, et les structures institutionnelles.

Le secteur de l'Information

Le fonctionnement du secteur de l'information en Afrique Tropicale présente des déficiences qui expliquent, dans une large mesure, le fait que les politiques agricoles en général et celles relatives à l'utilisation des engrais en particulier, soient formulées sur la base d'une connaissance inadéquate des variables techniques, économiques et institutionnelles.

Précisément, l'information en question concerne toute la filière, qui part du marché international des engrais jusqu'au niveau du paysan, en passant par les institutions nationales s'occupant de près ou de loin des engrais chimiques.

La connaissance du marché international des engrais constitue une donnée importante qui permet aux responsables, chargés des approvisionnements, d'avoir accès à des produits de bonne qualité et à des prix compétitifs. Les économies de devises, qui en découlent, peuvent être substantielles. Ainsi, la collecte et la dissémination de l'information, en cette matière, constituent une nécessité.

Le fonctionnement du circuit intérieur dans les différents pays de la région est parfois mal connu et une dislocation de l'information existe entre les institutions de recherche, le service de vulgarisation et les différents services du gouvernement concernés par les engrais. Ce manque de diffusion de l'information au sein du pays ne permet pas aux divers intervenants de travailler efficacement.

La dissémination des résultats de recherches, effectuée dans le pays entre les chercheurs, les responsables politiques, les analystes, les vulgarisateurs et les paysans, permet aux responsables de redéfinir leur politique, et aux chercheurs de réorienter leurs programmes de recherches.

En outre, les institutions d'enseignement doivent être associées d'une façon très étroite à cet échange d'informations, car elles forment les responsables politiques, les chercheurs, les vulgarisateurs et les agriculteurs de demain.

L'échange des informations sur la recherche, les méthodes de vulgarisation, l'organisation institutionnelle (particulièrement celle touchant au crédit, à l'approvisionnement, à la distribution et à la commercialisation des engrais) doit être encouragés dans la région. Les centres régionaux et internationaux peuvent apporter leur concours dans ce domaine.

L'approvisionnement en Engrais

Il est clairement apparu aux cours de nos discussions que l'approvisionnement en engrais ne se fait pas d'une façon efficace. Outre la solution aux problèmes de gestion, il convient également d'examiner un certain nombre de mesures susceptibles de réduire davantage les coûts liés à l'approvisionnement, au stockage et à la distribution des engrais dans nos pays.

Parmi ces mesures, on pourrait envisager l'importation des engrais en vrac, à haute teneur, assurer leur conditionnement dans le pays ainsi que la suppression de toutes les taxes douanières et autres. Les engrais devraient d'ailleurs être considérés comme des produits stratégiques au même titre que les produits pétroliers.

Thèmes de Recherche

Un certain nombre de thèmes de recherche ont été retenus au cours du séminaire comme thèmes prioritaires, intéressant presque tous les pays subsahariens. Ces thèmes peuvent être classés en deux catégories :

(1) l'étude de l'environnement économique dans lequel opère le paysan ;
(2) l'étude des aspects agronomiques et sociologiques relatifs à l'utilisation des engrais chimiques.

L'analyse de l'environnement économique proposée se veut globale, c'est-à-dire que toutes les variables économiques critiques affectant l'ensemble du système de production agricole doivent être examinées. Ces variables comprennent entre autres : les prix des produits agricoles et des engrais chimiques, la surévaluation de la monnaie locale, le fonctionnement du système de commercialisation des différents produits agricoles, le crédit agricole, la subvention aux engrais et autres intrants, le système foncier, le risque et le processus de prise de décision au sein du ménage agricole.

En premier lieu, l'ensemble de la recherche agronomique liée aux engrais doit se pencher sur la détermination de la réaction aux engrais des cultures pures et associées dans différentes conditions édapho-climatiques. En second lieu, la recherche des voies et des moyens visant à augmenter l'efficacité, en matière d'utilisation des engrais sous les tropiques, doit être poursuivie avec rigueur. A ce niveau, l'impact de la complémentarité entre les engrais, les autres facteurs modernes de production et le rôle des techniques culturales améliorées, doit également être explicitement examiné.

Réformes Institutionnelles

L'importation, la production, la distribution et la commercialisation des engrais chimiques, dans la plupart des pays subsahariens, sont contrôlées directement ou indirectement par l'Etat. Ce cadre institutionnel semble expliquer, dans une certaine mesure, la faible performance du sous-secteur des engrais dans plusieurs pays africains. Une analyse des possibilités de réformes institutionnelles mérite d'être proposée. La réforme actuellement en cours au Cameroun constitue une expérience à examiner attentivement.