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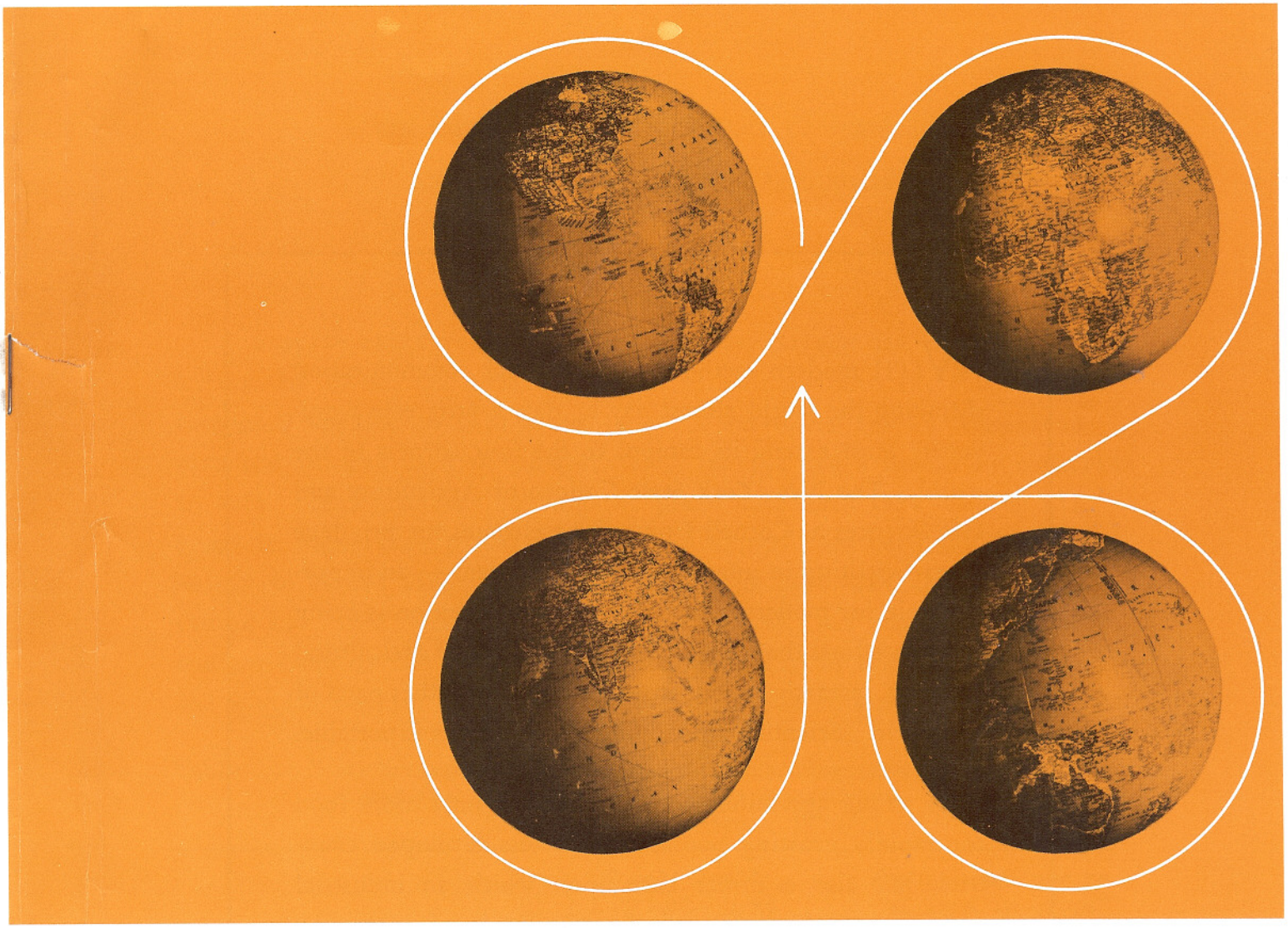

THE PRESENT AND POTENTIAL ROLE OF FERTILIZER IN MEETING NIGERIA'S FOOD REQUIREMENTS

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THE PRESENT AND POTENTIAL ROLE OF FERTILIZER IN MEETING NIGERIA'S FOOD REQUIREMENTS

K. L. Robinson and A. O. Falusi*

Despite rapid rates of increase in fertilizer use in Nigeria during the 1960s, the total amount of plant nutrients (N, P_2O_5 and K_2O combined) applied to food crops is still extremely low in comparison with the amounts used in Europe, North America and a number of countries in Asia. Only about 13,000 tons of plant nutrients were used on all crops in Nigeria in 1970-71 and another 62,000 tons were applied, mainly to export crops, in eight neighboring West African countries (Table 1). Total use in the region amounts to less than one half of one per cent of the amount now applied annually in the United States and a still smaller proportion of that consumed in Europe. The

Table 1. Estimated Consumption of Plant Nutrients, Total and Per Hectare of Land Planted to Crops, Selected Countries and Regions, 1970/71

Country or Region	Total Plant nutrients used* (thousand m.t.)	Amount used per ha. of land in crops+ (kg./ha.)
Nigeria	13	.6
Eight other West African Countries#	62	2.1
U.S.A.	15,320	87.0
Europe	24,983	170.0

* N, P_2O_5 and K_2O combined

\+ Based on the area planted to annual and permanent crops

\# Cameroon, Dahomey, Ghana, Guinea, Ivory Coast, Liberia, Sierra Leone and Togo

Source: FAO, Production Yearbook, Vol. 25, 1971.

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quantity of nutrients distributed in Nigeria in recent years is equivalent to less than one kilogram of plant nutrients per hectare of land in crops. In contrast, farmers in Western Europe apply an average of about 170 kilograms per hectare, while in Japan, use exceeds 300 kilograms per hectare.

Present Contribution of Fertilizer to Food Production

Precise figures on the allocation of fertilizer between export and food crops are not available, but an analysis of the regional distribution of fertilizer and the results of farm surveys indicate that over 70 per cent of the fertilizer purchased during the 1960s was distributed in the former Northern Region and, of this, about 60 per cent was used on groundnuts and cotton (Laurent, 1969). The proportion used on food crops is probably even lower in the Southern half of the country. In Western State, for example, about 80 per cent of the fertilizer is used on non-food crops, principally tobacco and cocoa (Falusi, 1973). Thus, of the 13,000 tons of nutrients distributed in 1970-71, not more than 5,000 tons could reasonably be allocated to food crops. At average conversion rates of fertilizer into grain production (about 10 tons of grain or the equivalent in root crops per ton of plant nutrients applied), this is sufficient to add approximately 50,000 tons of grain, which is less than one half of one per cent of Nigeria's annual output of starchy-staple foods, including root and tuber crops converted to grain equivalent.[1/]

1/ This estimate is based on production figures obtained from FAO, (1973) and Olayide, et al, (1972). Estimates derived from the two sources both fall in the range of 14 to 16 million tons of grain equivalent. Cassava and yam production figures have been converted into grain equivalent on the basis of their caloric value. From 3.5 to 4.0 kilograms of cassava and yams are roughly equivalent in caloric value to 1 kilogram of maize or rice.

Patterns of Use as Revealed by Sample Surveys

Farm surveys confirm what the aggregate figures imply, namely that only a small proportion of farmers now use any fertilizer. Furthermore, those who buy fertilizer apply it sparingly and to only part of their cropland. The proportion of farmers using fertilizer is highest in the areas of Northern Nigeria where groundnuts and cotton are important cash crops, but even in these areas, a survey of farmers conducted in the late 1960s revealed that only 29 per cent of them bought any fertilizer (Tiffen 1971). The proportion of users falls rapidly as one moves South. In Western State, probably not more than five per cent of all farmers apply any mineral fertilizer (Falusi 1973). Even where use has been promoted, as under the Western State Rice/Maize project, results have sometimes been disappointing. Williams and Alao (1972) found that, although 95 per cent of a sample of farmers participating in the Rice/Maize Scheme in 1971 acknowledged having received advice on the use of fertilizer, only 60 per cent actually applied fertilizer to their rice or maize in that year.

Among the minority who do purchase fertilizer, surveys indicate that the quantity they use is typically very limited. Interviews with a sample of fertilizer users conducted in three states of Nigeria in 1971 revealed that the average quantity purchased ranged from less than three bags (50 kg. each) in Western State to about six bags in Kano (Table 2). Moreover, farmers who bought fertilizer applied it to only one third to one half of their cropland. The quantity purchased was sufficient to provide no more than 15 to 20 kilograms of plant nutrients per hectare of land fertilized.

Factors Limiting Fertilizer Use

In an attempt to find out why farmers in Nigeria are using such limited quantities of fertilizer, samples of non-users as well as users of fertilizer were interviewed in three States of Nigeria in 1971. The

Table 2. Characteristics of Fertilizer Users, Sample Survey, Western, Benue Plateau, and Kano States, 1971

	Western	Benue Plateau	Kano
Size of sample (number)	151	54	71
Average size of farm (ha.)	4.9	5.9	7.8
Per cent of land fertilized	32	40	52
Number of 50 kg. bags purchased per farm	2.7	4.0	5.9
Estimated total plant nutrients applied per hectare of fertilized land/(kg.)	15	15	20

Source: Falusi, 1973, pp. 57-58 and 106.

two most frequently cited reasons for not using fertilizer were the lack of money or credit to finance purchases and the unavailability of fertilizer when needed (Table 3). Unavailability was more frequently reported as a limiting factor in Benue Plateau State than in either Western or Kano States. As might be expected, non-users mentioned the lack of economic response to fertilizer or unfavorable price relationships as constraints much more frequently than users. The latter must have been convinced of the profitableness of using fertilizer or they would not have purchased it.

Table 3. Reasons Cited by Farmers for not Using or for Limiting Purchases of Fertilizer, Sample Survey, Three States of Nigeria, 1971

Reasons Cited	Users (278)	Non-users (207)
	Per cent of respondents	
Lack of money or credit	51	52
Fertilizer not readily available	40	34
Poor response and/or uneconomic returns	2	36
Unfavorable price/cost relationships	11	19
Other	31*	10

* Including users who reported they purchased all they could manage.

Source: Falusi, 1973, pp. 112-114.

Farmers unquestionably are short of capital, but the emphasis given to this constraint is somewhat puzzling in view of the fact that fertilizer is a relatively low-cost innovation and normally requires much less cash than, for example, hiring additional labor or tractor services. Among users sampled in 1971, the average expenditure on fertilizer was only $3 to $8 per farm, whereas an average of over $70 was spent on hired labor on the same farms. Other studies also have shown that expenditures on labor and other inputs usually exceed by a wide margin the amounts spent on fertilizer (Akinwumi, 1970; Tiffen, 1971 and Norman, 1972). Farmers apparently think that returns from hiring additional labor, machinery or animal power are greater than those that might be realized by purchasing additional fertilizer. In many cases farmers have chosen to invest in relatively expensive innovations such as mechanical plowing in preference to spending modest amounts on fertilizer.

Among the factors that have retarded use of fertilizer on food crops have been the unavailability of responsive varieties and, in some cases, uncertainty with respect to yield increases that might be obtained. Experience elsewhere has shown that technical innovations which raise yields only 15 to 20 per cent are not particularly attractive to farmers. Increases in yields must be in the range of 50 to 100 per cent and reasonably well assured before a large proportion of cultivators can be expected to adopt new techniques of production.

Expected gains from fertilizer use, with varieties which were generally available in the 1960s and price relationships prevailing at that time, simply were not attractive enough to induce large numbers of Nigerian farmers to apply fertilizers to food crops. The results obtained from FAO trials and demonstrations conducted jointly with the State Governments in Nigeria during the 1960s showed that the application of modest amounts of fertilizer was quite profitable on groundnuts and lowland or swamp rice, but with traditional varieties of low-valued food crops such as maize, millet, sorghum and cassava, the application

of fertilizer was only marginally profitable (Couston 1971). Furthermore, yield responses were not consistent. The application of ammonium sulphate to sorghum, for example, produced significant increases in yields in only about half the trials conducted in the savannah region in the early 1960s (Goldsworthy 1967).

Recent Changes Favoring Increased Use of Fertilizer

Several changes have occurred recently that could lead to greater use of fertilizer on food crops. Among these are higher prices for food crops, the availability of improved varieties of maize, sorghum and rice which have the capacity to make effective use of much larger quantities of applied nutrients, and some improvement in credit facilities for farmers.

A favorable ratio between crop and fertilizer prices is a necessary, but not a sufficient condition to encourage use. Throughout the 1960s, the prices of staple food crops in Nigeria were too low, especially at harvest time, to offer the farmer much incentive to use fertilizer. During the early 1970s, however, the situation began to change. Between 1968 and 1973, wholesale prices of the major food crops (except rice) more than doubled. Fertilizer prices during this period remained approximately constant, with a substantial part of the costs of distribution being paid for by government subsidies. At crop prices prevailing even before the effects of the 1973 drought became apparent, it required only a little more than three kilograms of maize or sorghum to pay for one kilogram of plant nutrients, and only two kilograms of rice (Table 4). These are more favorable ratios than prevailed in the United States during the decade of the 1960s when use of fertilizer on grain crops rose very rapidly.

Generally, fertilizer use becomes unattractive to farmers if it requires as much as eight to 10 kilograms of grain to pay for one kilogram of N or P_2O_5. Fertilizer use is quite profitable with improved varieties at a ratio of five to six. Thus, farmers in Nigeria are likely to find purchasing fertilizer a profitable investment even if the price of nutrients (reflecting higher world prices) were to increase by 50 per

Table 4. Relationship Between the Prices of Selected Food Grains and Plant Nutrients, Nigeria and U.S.A., 1970/71

Product	Kg. of Product to Pay for One Kg. of Plant Nutrients*	
	Nigeria	U.S.A.
Maize	3.2	5.0
Sorghum	3.3	6.0
Rice (Paddy)	1.9	2.4

* Based on subsidized prices of ammonium sulphate and single superphosphate in Nigeria (including local transport costs) and actual prices paid by farmers in the United States for the same fertilizers. The cost per kilogram of plant nutrients obtained from urea, triple superphosphate and high analysis mixed fertilizer, of course, is less in both countries.

Sources: FAO, Production Yearbook, Vol. 25, 1971, Reports of the Western State Ministry of Agriculture and Natural Resources, and Falusi, 1973, pp. 157, 193.

cent or more, provided crop prices remain somewhere near the level prevailing in 1973. The ratio between fertilizer and crop prices obviously is more important than the absolute level of fertilizer prices. As a guide to policy, it would be desirable to adjust annually the subsidy rate on fertilizer so as to insure that farmers need to sell no more than five or six kilograms of grain to pay for one kilogram of actual nutrients if the objective is to encourage use of fertilizers on food crops.

The development and acceptance of improved varieties of rice, maize and sorghum also can be expected to have a positive effect on the demand for fertilizer in the years immediately ahead. A distinguishing feature of the new varieties that are now being introduced is the capacity to make effective use of much larger quantities of plant nutrients. Recommended rates of application for the improved varieties fall generally in the range of 100 to 200 kilograms of plant nutrients per hectare. These are three to four times the rates of application recommended for traditional varieties, and as much as 10 times the average amounts actually applied by the farmers surveyed in 1971.

The increases in yields that can be expected using the new packages of technology are, of course, much more dramatic than those obtained in the 1960s when very small amounts of fertilizer were applied to traditional varieties. A doubling of yields, often from less than one ton per hectare with traditional varieties and practices, to two tons or more per hectare with the new varieties and appropriate fertilization, weeding and tillage practices is not uncommon. Yield increases of this magnitude were obtained in 1973 by farmers growing maize in Badeku village near Ibadan and at Daudawa in North Central State (Patel 1973 and Norman 1974). Undoubtedly, the success of these demonstrations will encourage adoption of new varieties and much higher rates of fertilizer application by other farmers.

Projections of Future Use

A review of past projections of fertilizer requirements in Nigeria reveals a tendency to overestimate future use. Recent consumption figures generally have been below levels projected for the 1970s which were based on rates of increase experienced in the 1960s. Estimates of nutrient requirements for 1980 which were prepared by FAO in the mid 1960s (FAO 1966), for example, are about seven times the amounts used recently. A compound growth rate of about 40 per cent per year would be required during the remainder of the decade to reach the FAO projected level of use.

Simple trend analysis has not proved to be a very accurate method of forecasting future use. An alternative approach is to base forecasts on crop-by-crop projections of the proportion of land likely to be fertilized and then to multiply these estimates by probable changes in average application rates. Estimates of total nutrient use up to 1979-80 have been made for Nigeria using this method. Assuming moderate increases in the proportion of acreage fertilized (from less than five per cent in the early 1970s to somewhere between 10 and 15 per cent for most food crops by 1980) and some increase in average application rates based on current recommendations, total use (in terms of plant nutrients)

has been projected to increase to about 70,000 tons by the end of the present decade (Falusi 1973). This is slightly more than five times the amount distributed in 1970-71.

While the rates of increase projected are quite high, the effect of such changes on total food supplies is likely to be extremely modest. The proportion of fertilizer used on food crops undoubtedly will rise over the remainder of the decade, but even with the projected changes, the total increment in the food supply of Nigeria in 1980 attributable to fertilizer would amount to only about two per cent.

Much more rapid rates of increase in fertilizer use than those projected would be required if a major part of the annual increment in food requirements were to be met by raising yields on existing land rather than by extending the margin of cultivation, as has been done in the past. This becomes abundantly clear if one calculates fertilizer requirements based on the amount needed to meet minimum caloric needs of a population growing at the rate of about two million per year. If one assumes a minimum annual allowance of 200 to 250 kilograms of grain equivalent per person, the annual increment in total grain production (or the equivalent of root and tuber crops) required would be at least 400,000 tons. Undoubtedly, a large part of this increment will be met by increasing the area of land devoted to food crops, but if, instead the entire increment were to be met by raising yields, it would require an additional 40,000 tons of plant nutrients each year (assuming that one ton of plant nutrients if applied to food crops will yield approximately 10 tons of additional grain or the equivalent of root crops).[2/]

2/ This estimate of the incremental ratio probably falls on the conservative side for improved varieties. Experiments conducted with improved maize at Mokwa and Samaru in the Savannah zone, and at IITA in the Forest Zone have shown that incremental ratios of as high as 12 to 14 kilograms of grain per kilogram of plant nutrients can be achieved with application rates of 80 to 120 kilograms of appropriate combinations of plant nutrients (Heathcote and Stockinger 1971). Average incremental ratios exceeding 10:1 also have been reported for improved rice varieties (Williams 1973).

Even if only one third to one half of the increment were to be met by applying fertilizer to food crops, annual additions to fertilizer requirements could well exceed the total amount of fertilizer purchased by Nigerian farmers in 1970/71. Storage and handling facilities would have to be expanded by a multiple of somewhere between five and eight by 1980 if Nigeria were to rely on yield-increasing technology to supply a significant amount of its additional starchy-staple food requirements over the next five to 10 years.

Summary and Policy Implications

The present contribution of fertilizer to the total output of food crops in Nigeria is extremely limited owing to the low level of use on such crops. Less than one kilogram of actual nutrients is applied per hectare of land in crops; moreover, a high proportion of the fertilizer purchased is now used on export rather than food crops. In the early 1970s, fertilizer added the equivalent of less than one half of one per cent to the total supply of starchy-staples.

Fertilizer use on food crops has been constrained in the past by such factors as the unavailability of fertilizer-responsive varieties, unfavorable price relationships, lack of credit, and deficiencies in the procurement and delivery system. Apparently, very few farmers have found it profitable, at least until recently, to use fertilizer on food crops, except for lowland or swamp rice and improved maize. The unavailability of supplies locally when needed also has prevented many farmers from using more fertilizer.

Growth in demand for fertilizer over the remainder of the decade will be influenced in part by the rate at which improved varieties of the major food crops can be developed and introduced. While more responsive varieties of rice and maize have been developed, much remains to be done, especially for root and tuber crops. There is an obvious need for additional research to develop technically superior and economically viable packages of new technology for the major food crops.

The conditions under which large and consistent yield increases can be obtained also need to be identified. Experimental evidence suggests that the response to additional applications of fertilizer varies greatly depending on such factors as the variety, soil type, previous cropping history or sequence of crops, weeding and tillage practices and, of course, rainfall distribution. This suggests the need for conducting fertilizer experiments at many different locations and with alternative cropping sequences. It is economically more important, given the present world supply-demand situation for fertilizer, to identify areas and conditions under which large and consistent yield responses can be obtained than to attempt to define more precisely the production function for a particular soil type and crop. Only with this kind of information will it be possible to allocate the available supplies in such a way as to maximize gains in output.

The availability of more responsive varieties together with some improvement in crop prices is likely to accelerate growth in demand for fertilizer over the remainder of the decade. If food crop/fertilizer price relationships are maintained somewhere near the level which prevailed in 1973, farmers are likely to find it profitable to use much more fertilizer than in the past. It is not unreasonable for Nigeria to plan on as much as a five-fold increase in the quantities of fertilizer distributed by the end of the current decade. This will require a large expansion in storage and distribution facilities, and perhaps credit as well, particularly in areas where consistent economic responses can be obtained.

If potential gains in use are to be realized, substantial improvements must be made in the delivery system for fertilizer. The evidence is overwhelming that availability is one of the most important determinants of use. Farm surveys indicate that many farmers would apply more fertilizer if they could obtain it locally and at the right time. The problem of lagging agricultural production can be solved in part simply by stocking more fertilizer and making it available in areas where its use is likely to prove profitable.

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