AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION

A. PRIMARY: Agriculture — AF25-0000-GG40

B. SECONDARY: Soil fertility,fertilizers,and plant nutrition--Near East-South Asia

2. TITLE AND SUBTITLE

Role of fertilizer in agricultural development in the CENTO countries

3. AUTHOR(S)

Russel,D.A.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1974	23p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS

TVA

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

(Presented at CENTO Sem.on Key Management Problems in the Marketing,Distribution, and Use of Fertilizers,Islamabad)

9. ABSTRACT

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN- RAA-179	
12. DESCRIPTORS	**13. PROJECT NUMBER**
Near East South Asia	**14. CONTRACT NUMBER** PASA TA (QA) 6-69 GTS
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

10

TVA 275-6

ROLE OF FERTILIZER IN AGRICULTURAL DEVELOPMENT IN THE CENTO COUNTRIES*

Darrell A. Russel
National Fertilizer Development Center
Tennessee Valley Authority
Muscle Shoals, Alabama

---

01. BLACK SLIDE

I am most happy to participate in this seminar with you. This is my first visit to this particular section of the world but I have been aware of your problems – and of your triumphs, too – for a long time. From time to time I have met and worked with representatives from each of the CENTO countries. Each has been a sincere, dedicated worker. Now, I have the opportunity to work even more closely with you. I expect to learn much that will be useful in other assignments and I hope that I will be able to pass on some ideas that will aid each of you in your assignment.

Each of us has read the background and objectives of this seminar. Probably each of us has developed a different opinion of what is supposed to be accomplished. Even at the conclusion of the conference, after we all have participated in the same discussions and heard the same words, each of us will have learned different things. This is similar to the situation that I have regarding the title of my presentation. The same title has been used by fertilizer experts for many other occasions. Regardless of the sameness of the titles, the

02. ART: CARTOON
The changes that occur in a statement as it passes from one person to another

---

*Presented at the CENTO Seminar on Key Management Problems in the Marketing, Distribution, and Use of Fertilizers; January 7-10, 1974, Islamabad, Pakistan.

messages that have been presented have been remarkably varies. Each writer or speaker has utilized his own unique knowledge of, and experience with, fertilizer to asses its role in agricultural development. For this reason, I did not hesitate to accept the invitation to discuss the role of fertilizer in agricultural development with you. My experiences are different from those of any other speaker and I will emphasize different aspects. I am sure each of you will hear different things during my presentation.

03. ART:
DEVELOPMENT

Before starting my discussion, I want to define a few terms. Let's start with DEVELOPMENT. The dictionary definition refers to a gradual advance or growth through progressive change. This is an across-the-board definition. No specific sector is named. From a country or national viewpoint, development undoubtedly refers to an improvement in the standard of living of the people. This improvement can be – indeed must be – in many aspects: health, education, relief from drudgery, enlightened leadership, a market for surplus production, a chance to watch television, a whole host of other things. Development is usually subdivided into such broad categories as social, institutional, economic, and the like. Economic development is the most appropriate for us to consider because it is the category in which agriculture usually is placed. Perhaps I should emphasize "usually". Agriculture can and does affect social and political development but its chief effect is economic.

04. ART:
DEVELOPMENT
....
Economic
...

ECONOMIC DEVELOPMENT is the growth in output per head of population and the changes in the structure of the economy under discussion. A high priority must be given to agriculture in economic development, if for no other reason than that more people are engaged in agriculture than in any other activity. In the developing countries, 75% of the population obtains its livlihood from agriculture and in some countries as many as 90% of the people are dependent upon agriculture.

05. ART:
DEVELOPMENT
....
Economic
...
Agricultural
...

AGRICULTURAL DEVELOPMENT is a series of positive acts consciously initiated in order to modernize traditional production and marketing systems. The objectivity is to increase productivity. It is at this point that so many programs run into difficulty. Frequently, there just isn't enough funds for development, including agricultural development, to proceed as fast as it should. Occasionally, the importance of agriculture is not recognized in the total development program and its development is underfunded.

Agricultural development is important in the total development program. Rostow, in his book on The Stages of Economic Growth, has stated that ". . . the rate of increase in output in agriculture may set the limit within which modernization proceeds." Agricultural improvement contributes to economic development in several ways:

a. It provides food and fiber for an increasing proportion of the population working outside of agriculture.

-MORE-

06. ART: Table 1

U.S. agricultural productivity

Year	No. of persons supplied per farm worker
1950	15.5
1955	21.7
1960	25.8
1965	37.0
1970	47.1

To illustrate how effective agricultural development can be in this respect, Table 1 provides information about the productivity of U.S. agriculture. In 20 years, productivity more than tripled. Most of the drudgery formerly associated with agriculture also has succumbed to mechanization.

b. Agriculture produces for export and thus earns the foreign exchange needed to import industrial and consumer goods. Agricultural exports have been almost the only source of foreign exchange for many of the developing countries. Table 2 shows that this is also the case for the CENTO countries although it applies more to Pakistan and Turkey than to Iran. Oil exports in Iran finance most of the imports into the country. Under normal conditions, agriculture would be the major source of foreign exchange earnings.

07. ART: Table 2

CENTO exports and imports

	Iran 1965/66	West Pakistan 1968/69	Turkey 1970
	million reals	thousand rupees	thousand lira
Agr. exp.	6440	1156	5587
Other exp.	7542*	2098	820
Imports	66517	4233	9598

*Excludes oil

c. Agriculture provides market outlets for concumer goods and services from other segments of the economy.

d. Agriculture also provides raw materials for industries engaged in processing agricultural products. For example, here in Pakistan, exports of items manufactured from cotton were valued at twice the exports of raw cotton in 1968/69.

e. The surplus earnings from the sale of agricultural products, both within the country and as exports, provides capital for investment in industrial and business enterprises.

f. Agriculture also provides its surplus manpower to other trades and professions.

Because agricultural development is so important to the total economy of a country, we must be sure that we understand the development process. There are four key statements that apply to agricultural development:

08. ART:
Accompany or precede

09. ART:
Grow it before you eat it

10. ART:
Inside, not outside

11. ART:
KNOWLEDGE: Key to Success

12. ART: Identical to 08
Accompany or precede

a. Agricultural development must accompany or precede industrial development.

b. Increases in production must precede increases in consumption.

c. Development takes place inside an area – not outside.

d. Use of knowledge is the key to success.

Let's examine each of these statements to determine their validity and applicability to the three CENTO countries. M.H. Khan has written a book on The Role of Agriculture in Economic Development using Pakistan for a case study. He states that, "Most of the contemporary underdeveloped economies have a distinct dual character. In such economies a small market sector, which comprises almost all the industrial activity, . . . is superimposed upon a large subsistence sector producing food and other such commodities which are used primarily for self-consumption of the agricultural population . . . [Assuming that] an indistrial sector has to emerge and sustain itself, the agricultural

sector must increase its total output right from the beginning . . ." The reason for this, Khan explains, is that the new industrial sector will draw upon agriculture for its new labor force. Even though these ex-agriculturists were not fully employed in agriculture, their leaving creates a void that must be filled by those who remain. These workers must now work harder and longer and consequently will eat more. Those who leave agriculture also will work harder and longer and they, too, will eat more. The net effect is that, for each man who leaves the agricultural labor force, agriculture must increase production on an almost equivalent basis. Any attempt, then, to establish an industrial sector without simultaneously developing the agricultural sector will result in larger and larger shortfalls in food production.

13. ART: Identical to 09
Grow it before you eat it

In 1963, F.W. Parker estimated that one-half of the world's population suffered from some form of hunger or malnutrition. Despite the advances made in agricultural production, about one-half of the world's population still suffers from some form of hunger or malnutrition. There are still many, many countries in which the population is increasing at a rate equal to or faster than agricultural production. The only way that a hungry person can have more food to eat is for more food to be produced. Increases in production <u>must</u> precede increases in consumption.

		We have had this problem in the valley of the Tennessee River. In fact, this is one of the reasons for establishing the Tennessee Valley Authority. It was a depressed area, made up almost wholly of subsistence agriculture.
14.	PHOTO: Landess 56	The soils were poor
15.	PHOTO: Landess 27	Farming methods were poor. Many of them actively promoted erosion.
16.	PHOTO: Landess 18	In some areas, erosion had proceeded so far that the land could not be reclaimed for cultivation.
17.	PHOTO: Davis 17	Due to erosion and intensive cropping, there was not enough fertility in the soil to support livestock.
18.	PHOTO: Davis 1	The people were poor,
19.	PHOTO: Landess 14	. . . and so was their housing.
20.	PHOTO: Davis 0	When TVA was created, the only resources that remained were the people and the worn-out soils. The first step was to make both productive – and so the initial emphasis was agricultural development.
21.	PHOTO: Davis 23	Thirty years later, farmers were following modern methods of erosion control.
22.	PHOTO: Davis 6	New homes began to replace the old.
23.	ART: TVA – UNIVERSITIES – FARMERS	Development started within the area as a cooperative effort among TVA, the land-grant universities, and the people.
24.	PHOTO: Landess 50	A lot of one-to-one personal contact was necessary to get farmers started on new paths.
25.	PHOTO: Landess 29	Dramatic demonstrations were established

26.	PHOTO: Landess 2	. . . . and were used for group discussion.
27.	PHOTO: Landess 1	Soon, neighbor was vying with neighbor on a whole farm basis to see who could produce the most.
28.	PHOTO: Landess 46	Knowledge was the key to success but much of this knowledge had to be developed through research. Ideas were tested in the greenhouse,
29.	PHOTO: Landess 47	then with small plots,
30.	PHOTO: Landess 46	and finally with large fields.
31.	PHOTO: Russel B3-SS2	After several years, the changes in agriculture were apparent to even the casual observer.
32.	PHOTO: Russel	Soon after agriculture was started on the path of development, industrial development was started. The Valley is now a mixture of productive agriculture and industry.
		Agricultural development does not occur spontaneously. It has to start at a definite place with a definite act. Khan said that the principal question is how to induce "traditional agriculture" to produce
33.	PHOTO: Shahpur publication	more. A statement in some of the literature from the Shahpur Chemical Company in Iran is significant: "Of all the aspects of the 'New Technology' that affect the creation of a powerful agricultural base, the proper use of chemical fertilizers on soils certainly represents the input that is least expensive to apply, simplest to evaluate and control, most dramatic in effect, and quickest in realization of return."
34.	PHOTO: Russel NFDC facilities	This is a familiar statement to those of us who work for the Tennessee Valley Authority.

At an FAO conference in Colombia, Dr. L.B. Nelson, Manager of TVA's National Fertilizer Development Center, stated: "Traditionally, in the United States, and I suppose in most developed countries, we look upon fertilizers as a low-cost way to increase output per acre of land and give the farmer a high economic return for his labor and capital investment."

On another occasion, Parker and Nelson concluded that plant nutrients were the major limiting factor for agricultural development in the least-developed countries. They, as have so many others, were careful to point out that fertilizer alone would not suffice. For fertilizer to be effective, there must be good seed and adequate water; there must also be protection from insects and disease; and there must be an adequate market.

Agricultural economists have conducted a number of studies to relate quantitatively the contribution of fertilizer to increases in crop yields. In 1965, Heady and his associates at Iowa State University estimated that 45% of the average annual increase in yields of all crops in the United States over the past several decades came from fertilizers. Of the remainder, 6% came from irrigation, 10% from the introduction of hybrid corn, and all the rest from improved seeds, improved cropping practices, and other innovations.

35. ART:

Yield increases (U.S.)

Fertilizer	45%
Irrigation	6
Hybrid corn	10
All other innovations	39

Ibach concluded that from the mid-fifties to the early sixties about 36% of the change in crop production per acre could be attributed solely to increased rates of fertilizer application.

The U.S. Department of Agriculture studied crop production changes occurring from 1948 to 1963 in 26 developing countries and concluded that additional fertilizer consumption accounted for one-fifth to two-thirds or more of the increased grain yields.

36. BLACK SLIDE

There can be but little question that fertilizer is one of the most far-reaching and significant inputs. But, it has become an important factor in agricultural production only in comparatively recent years. Outside the developed countries, fertilizer is used on only a very small percentage of the cropland. There are still areas throughout the world where alternative methods of increasing agricultural production would be economically more feasible than using fertilizers. Bringing new land into cultivation, which is possible in several of the Latin American countries, and shortening the fallow rotation, which is possible in some African countries, are two of these alternatives. Improved management practices also are possible but these usually are not developed until relatively late in the process of modernizing agriculture.

The next most important question, then, is when should fertilizer be used as an input to increase total agricultural production. From the farmer's point ov view, the answer is fairly simple: whenever the benefit/cost ratio is high enough that there is not much of a gamble in using fertilizer. The cost of the fertilizer and the value of the agricultural products, however, are not controlled by the individual farmer but

rather by government policy. Thus, it is government officials who decide when fertilizers should be used. They also decide, consciously or unconsciously, how much fertilizer will be used and what crops will be fertilized. How, then, should these government officials make their decision? What information do they need to make an analysis that leads to a correct decision?

There are six major factors that should be considered:

a. The human factor,
b. Land tenure arrangements,
c. Capital, credit, and financial institutions,
d. Demand, prices, and output in agriculture,
e. Present yield levels, and
f. Size of farm holdings.

37. ART: Table 3

Literacy and fertilizer use in selected countries, 1965.

Country	Literacy rate	Fertilizer consumption
	%	kg/capita*
Spain	87	25.6
Costa Rica	79	19.8
Taiwan	54	17.8
Turkey	39	8.2
Pakistan	19	2.9
Iran	15	2.5
Nigeria	11	0.1
Sudan	7	3.4

*Kg N + P + K/capita total population.

There are three aspects of the human factor that are important. First, there is a high, positive correlation between the level of education of the farmer and fertilizer use. I have not been able to obtain reliable information on the level of education of farmers for most developing countries but the correlation still holds if the literacy rate for the country as a whole is used. Table 3, based on some rather old data, shows the correlation for several countries. If the correlation were perfect, which it is not, we would not need to consider any other factors. It appears that a literacy rate of around 50% is needed for fertilizer to be used in substantial quantities.

38. ART: Table 4

Extension workers, farmers, and fertilizer use in selected countries, 1965.

Country	Arable land/ exten. worker	No. of farmers /exten. worker	Fert. cons.
	1000 ha		kg/cap*
Thailand	34.4	34,555	2.4
Chile	29.3	4,208	8.2
Iran	17.9	5,130	2.5
Venezuela	15.7	2,331	4.4
Turkey	15.0	5,539	8.2
Taiwan	1.0	1,698	17.8
Greece	0.8	403	28.1
Israel	0.6	157	13.7

*Kg N + P + K/capita of total population.

Secondly, there is a close relationship between the number of extension workers in a country (or rather, the number per hectare of arable land), and fertilizer use. Again, I have used some old sources of information for certain data but the principle is still sound and useful. The results are given in Table 4. The relationship is inverse as presented. That is, the more land per extension worker, the smaller the quantity of fertilizer used per hectare. An almost identical correlation is obtained for number of farmers per extension worker and fertilizer use . It appears that there should be at least one extension worker per 1000 hectares of arable land or about one per 1500 farmers before fertilizer use can begin to expand. Government officials faced with a shortage of extension workers have a limited number of alternatives. At times, the first choice has been to do nothing because the alternative of increasing the size of the extension staff seems impossible. There is a third alternative: private sector extension workers. Usually, these would be called salesmen; when trained to know his job, a salesman can be a major source of information for farmers.

The third aspect of the human factor is research. Growth in man's capacity to produce foods and fibers has increased greatly through improvements in agricultural technology and increases in the capital and skills required to use the technology. Until the 19th century, most technological improvements were either accidental discoveries or products of relatively few individuals. Since the middle of the 19th century, a

steadily growing stream of improved agricultural technologies has developed. Most of this technology has developed in the United States, Europe, and Japan. Some of it is transferrable to tropical zones — such as high analysis fertilizers, agricultural equipment, some new varieties of crops, and the like. There is a need, nevertheless, for a great deal of applied research in the developing countries, as well as for some basic research. Without applied research, it would be most difficult to transfer technology from one country to another. The only data that I have seen that measure agricultural research in the developing countries are those obtained by the U.S. Department of Agriculture in its 1948-1963 survey of 26 developing nations. The data on the number of agricultural research workers per 100,000 farmers are listed in Table 5. A parallel listing shows fertilizer consumption for the same countries. Obviously, research is important for fertilizer use to expand. A country needs at least one agricultural research worker for each 5 to 10 thousand farmers in order to have sufficient fertilizer information to found a sound fertilizer use program.

39. ART: Table 5

Agricultural research and fertilizer consumption in selected countries, 1965.

Country	Agricultural research workers per 100,000 farmers	Fertilizer consumption
		kg/capita*
Taiwan	79	17.8
Yugoslavia	29	21.9
Greece	10	28.1
Spain	10	25.6
Iran	10	2.5
Colombia	9	5.9
Thailand	4.7	2.4
Pakistan	4.5	2.9
India	1.2	2.8

To summarize the human factor, there must be farmers who can at least read and write, there must be extension workers and/or salesmen who can tell farmers how to use fertilizers, and there must be research workers who tell the educators what to say.

40. ART:

b. LAND TENURE ARRANGEMENTS

Traditionally, in both developing and developed countries, fertilizer use and crop yields have been higher on land managed by owner-operators and by tenants who have a fixed rent per unit of land than by farmers who have a crop-share rent. Because of infloxibilities, crop-share leases tend to favor the landlord more than the tenant. As a result, the tenant has less incentive to use yield-increasing inputs such as fertilizer and better seed. For fertilizer use to increase, rental arrangements must be such that both the tenant and the landlord share in the increased output in the same proportion that they share the expenses. Where these arrangements are not made, fertilizer use and agricultural output increase more slowly than is needed in most developing countries. I have been unable to support the fertilizer portion of these statements with statistical data but some of the 1960 data from Iran shows the effect of tenure on crop yields (Table 6).

41. ART: Table 6

Effect of tenure on crop yields in Iran, 1960.

Crop	Crop share rental	Owner operated	Fixed rent
		kg/ha	
Wheat	735	883	931
Barley	680	798	1244
Rice	2164	2325	2281
Cotton	1005	1198	1332

42. ART:

c. CAPITAL, CREDIT, AND FINANCIAL INSTITUTIONS

Historically, the shift from subsistence farming to commercial farming has always required increasing use of capital. Few farmers are able themselves to finance the higher costs of improved seeds, fertilizers, agricultural chemicals, irrigation, mechanization, and/or other practices that are used to increase production. To illustrate the change in demand for credit, Table 7 shows a 5-year projection for credit needs in India. The data show that , at the time of the projection, about half of the farmers were borrowing – mostly from local money-lenders – in order to finance crop production.

43. ART: Table 7

Effect of agricultural modernization on needs for farmer credit in India.

Crop year	Fertilizer sold on credit
	% of sales
1966-67	50
1967-68	55
1968-69	60
1969-70	65
1970-71	70

With the introduction of high-yielding varieties of wheat and rice and the government program to intensify cereal production, it was expected that more and more farmers would have to borrow money. Presumably this projection was based on the estimate of the Sivaraman Committee on Fertilisers. This committee found that about half of the cultivators in India borrowed money for crop production during the Third Five-Year Plan (1961-62 – 1965-66) and estimated that 70% of them would have to use credit to purchase fertilizers by the end of the Fourth Five-Year Plan (1966-67 – 1970-71). A recently completed study of the marketing system in Mexico showed that 72% of the fertilizer sold to farmers was on credit. The 70% estimate seems realistic in view of a survey of 101 fertilizer firms in Oklahoma (U.S.A.) in 1971. This survey showed that exactly 70% of the farmers purchased their fertilizer on credit. Using the retail price of fertilizer and the tonnage estimates of fertilizer use, it is comparatively easy to calculate the amount of farmer credit that will be needed. It is much more difficult to supply the credit and to make it available through institutions that are attuned to farmer needs.

ART:

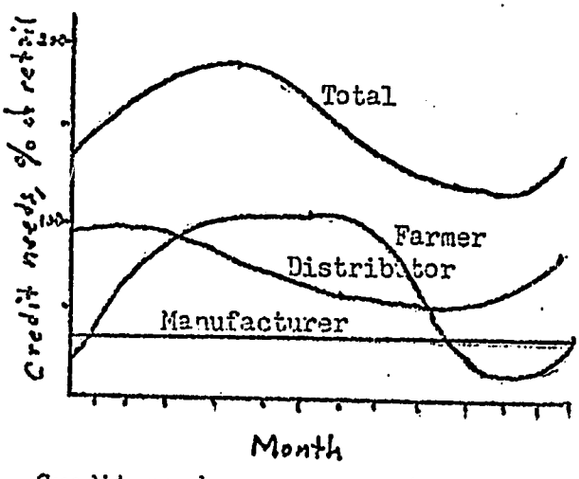
Crop Production
Distribution } CREDIT
Manufacturing

Crop production credit, however, is only a portion of the total credit needs for a progressive fertilizer program. Distribution credit and manufacturing credit requirements can be substantial. For example, marketing costs have been estimated to make up 22% of the consumer price of fertilizer in India and about a third of the selling price in

the United States and Europe. Despite these fairly low marketing cost estimates, a Fertiliser Credit Committee in India estimated that distribution credit requirements could be as high as 90% of the retail value of the fertilizer.

Manufacturers also have credit needs, in the form of investment in physical facilities and of working capital. Fertilizer facilities require an initial investment equivalent to 10-25% of the annual retail value of the product. Annual interest costs are 8-10% so that this portion of the capital investment adds a negligible amount to the credit needs. Working capital, however, is more important. Estimates of working capital needs range from 15 to 30% of the retail value of the product, calculated on a pre-tax basis.

45. ART:



Credit needs as a percentage of the retail value of fertilizer

Considering, then, the peak demand for credit for a progressive fertilizer program, it is fairly safe to estimate that an amount equivalent to 150-200% of the retail value of the fertilizer must be available. Average credit needs are not meaningful. Peak demand is the critical value. By peak demand, I mean that one instant in time, the one day of the year, that shows the maximum amount of money on loan for fertilizer. If a country cannot arrange for this credit to be available at the right time, at the right place, and in the right amount, the fertilizer program will suffer. Because it is impossible to make precise credit allocations, my best guess is that credit requirements should be set at 200% and then reduced as circumstances within a particular country or region might

suggest. For example, if the national objective is to use 100,000 tons of fertilizer, valued at $100 per ton, there needs to be $20 million of credit available in some form or another.

46. ART:

d. DEMAND, PRICES AND OUTPUT IN AGRICULTURE

The benefit/cost ratio is the relationship between the price a farmer receives for his crop and the cost of the fertilizer. This is one of the most influential factors affecting fertilizer use. It is also the factor most easily influenced by government policies.

47. ART:

$$\text{Benefit/cost ratio} = \frac{\text{value of INCREASE in crop yield}}{\text{cost of fertilizer}}$$

Two variables enter into benefit/cost ratios: commodity value and fertilizer cost. Both can be controlled by government actions. Unfortunately, many governments promote fertilizer use by controlling the cost of the fertilizer. That is, fertilizer costs are subsidized. Admittedly, this will increase fertilizer use, but not necessarily on those crops that are in short supply. Were the government to control the price of commodities so as to provide high benefit/cost ratios for those crops that needed an expansion in production, fertilizer use still would increase and so also would production of essential food crops. In many situations, free market conditions prevail and fertilizer use must stand on its own economic merits.

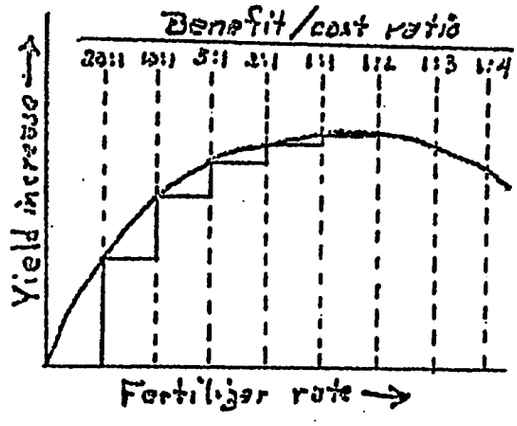
When the benefit/cost ratio exceeds 1.0 only slightly, farmers usually will not use fertilizer. The risk is too high. A crop failure one year out of five would require a ratio of 1.25 to break even. There are no precise rules for determining the

48. ART:

BENEFIT/COST RATIO

magnitude of the benefit/cost ratio needed to motivate farmers to adopt a new practice. Generally, it is thought that the ratio should be at least 3.0 in developed countries where farmers are more accustomed to trying something new and are more likely to be operating from a larger capital base. In developing countries, where farming practices may not have changed for a century or more, the benefit/cost ratio must be much higher – possibly 6.0–10.0 – and must be easily observed before farmers will try something new.

49. ART:



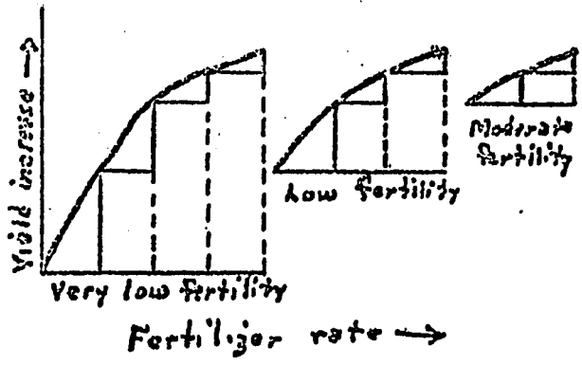
Two other items required for calculation of benefit/cost ratios are the quantity of fertilizer to be used and the increase in yield that results from its use. Because the fertilizer response curve is very similar to a graph of the Law of Diminishing Returns, it is comparatively easy to adjust fertilizer application rates to provide any benefit/cost ratio that is desired. The principle difficulty is adequate research data to determine the exact shape of the response curve for many crops on various soils under a range of climatic conditions.

50. ART:

e. PRESENT YIELD LEVEL

Government officials and agronomists for commercial fertilizer companies should be thoroughly familiar with the present yield levels of indigenous crops because they affect the ease of attaining national crop production goals and of fertilizer sales goals. A farmer's enthusiasm for fertilizer usually is in direct proportion to the increase in yield that he can observe or measure.

51. ART:



If he is farming fertile soils, yield increases from fertilizer are likely to be negligible and the farmer probably will concentrate his efforts on some other input. Few farmers in developing countries are in this category. Most of them are farming soils that are very low in fertility, either naturally or as a result of long-continued cultivation and croppting. Fertilizer usually causes some rather dramatic increases in yields – but there are many exceptions, of course.

There are two quantitative statements that relate to yield level. Both appear to have originated from studies by F.W. Parker who used FAO statistics. The first statement is that fertilizer use becomes essential when the national economy requires a level of agricultural production equivalent to 800-1200 kilograms of cereal grain per hectare.

52. ART:

Fertilizer use is essential when the national economy requires food production at a level equivalent to 800-1200 kg grain/ha.

The second statement is that countries using 20 or more kilograms of plant nutrients per hectare of arable land have satisfactory or very good levels of food supplies and human nutrition. (Some countries have satisfactory supplies at less than 20 kg of plant nutrients per hectare but no country has unsatisfactory supplies when use is 20 kg per hectare or higher.) This table (Table 8) illustrates the progress of the three CENTO countries toward satisfactory supplies when measured by this standard.

53. ART: Table 8

Plant nutrient use in the CENTO countries.

Country	1948-53	1962-63	1971-72
	kg/arable ha		
Pakistan	0.2	5.7	14.6
Iran	?	0.8	6.2
Turkey	0.6	2.7	17.4

54. ART:

f. SIZE OF FARM HOLDINGS

The size of farm holdings is important for two reasons. The most important is the effect on communications. For illustration, let us start with an extreme example. Suppose all the farm land in the three CENTO countries were owned by just one man. It should then be a comparatively simple matter to educate just one man about fertilizers and to keep him informed about the new developments. This, of course, is not the case; rather, the CENTO countries have an almost impossibly large number of farmers. Each farmer needs to be taught how to use fertilizer properly but this is not possible because of the limited number of extension workers. There is a possible solution to this dilemma. Moroccan data are used to illustrate the solution (Table 9). Avoiding for the moment all social and political considerations, the obvious procedure is to concentrate the fertilizer program on the modern farms and the traditional farms larger than 10 hectares. Almost exactly 50% of the arable land would be in the program but less than 6% of the farmers would be involved. As these farmers became more and more knowledgeable about fertilizers, the educational program would be shifted to farmers in the next smaller size group.

55. ART: Table 9

Number and size of farms in Morocco, 1967.

Type of farmin system	Farm size	Number of farmers	Total farm area
	ha		1000 ha
Trad.	0- 4	885,500	1200
	4- 10	165,500	1100
	> 10	56,000	1100
Modern	0- 50	1,500	50
	50-500	3,000	800
	>500	600	600

Socio-political considerations suggest that a pure economic approach cannot be adopted. Some attention must be given to the very small land holder. An effective program can still be conducted if extension agents are assigned on the basis of number of farmers to be serviced rather than land area.

Using this same Moroccan data, compare the land area that would be serviced if one agent worked with 50 traditional farmers with less than 10 hectares of land and another agent worked with traditional farmers operating more than 10 hectares. The first agent would service about 100 hectares while the second would be working with about 1000 hectares. No one could deny that the agents were not equitably distributed among the active farmers yet the second agent is very likely to promote the use of even more than 10 times the amount of fertilizer than the first agent.

56. BLACK SLIDE

Size of farm holdings is important from still another viewpoint. There is a very high correlation between size of farm and extent of mechnization. I have heard that mechanization is undesirable for agriculture in developing countries because it displaces too many people from the land. I am in complete disagreement with this philosophy. No man should be required to provide hours and hours of back-bending labor in order to reap a few handfuls of grain for his family. There is an easier way – and the sooner this easier way can be used, the better off mankind will be. It is true that mechanization releases a lot of labor from the agricultural sector. But, commercialization of agriculture creates new jobs in the transportation, food processing, implement manufacturing, administrative, and other sectors. These jobs rightfully belong to the people released from the agricultural sector. Government officials should make certain that educational programs are available for re-

training displaced agricultural workers so that they can qualify for the new jobs.

My objective in this presentation has been to quantify the six major restraints on fertilizer use – and to present specific information rather than generalizations. Some of the data are tenuous and probably need some adjustment before they can be applied to the three CENTO countries. Nevertheless, they can serve as starting points in a country-by-country evaluation. Let me summarize my presentation, then, by reiterating the six major restraints in the form of specific questions.

57. ART:
50% LITERACY ?

1. Does your country have a literacy of 50% literacy or higher? How many years will be required to reach this level of literacy with the present educational programs?

58. ART:
1 EXTENSION WORKER/1000 HA ?
or
1 EXTENSION WORKER/1500 FARMERS ?

2. Does your country have at least one extension worker per 1000 hectares of arable land or per 1500 farmers? If not, how many years will it take to reach this level? Are the commercial fertilizer programs designed to supplement the extension program with knowledgeable salesmen?

59. ART:
ONE AGRICULTURAL RESEARCH WORKER PER 5 TO 10 THOUSAND FARMERS ?

3. Does your country have at least one agricultural research worker for each 5 to 10 thousand farmers? If not, how many years will be required to reach this level? Are the commercial fertilizer companies prepared to fund some of the research?

60. ART:

FARMS OWNED AND OPERATED BY THE SAME PERSON OR RENTED FOR CASH ?

4. Does your country have a high proportion of farmers who own and operate their own farms or else rent on a fixed-fee basis? Do you have land programs that encourage ownership by farm operators?

61. ART:

CREDIT EQUIVALENT TO 200% OF THE RETAIL VALUE OF THE FERTILIZER ?

5. Do you have credit institutions that can service the manufacturer, the distributors, and the farmers? Are total available credits about double the retail value of the fertilizer projected for use?

62. ART:

BENEFIT/COST RATIO = > 6 ?

6. Do your farmers receive at least a 6:1 return on their fertilizer investment on those crops that require expanded production?

63. ART:

USE MORE LAND OR USE FERTILIZER ?

7. Does your country have excess land that can be placed into production or must production be upped to at least 800-1200 kilograms of grain per hectare?

64. ART:

20 KG PLANT NUTRIENTS PER HECTARE?

8. How many years will it be before your country is using 20 kilograms of plant nutrients per arable hectare? How fast must the rate of fertilizer application be increased to keep up with expanding population and increasing demands for food?

65. ART:

COMMERCIAL FARMING PROMOTED ?

9. Are your government educational programs and fertilizer sales programs designed to quickly convert large farms to commercial agriculture or are they faltering because of misplaced emphasis on the very small farmer?

66. BLACK SLIDE

If any country has answered "yes" to all these questions, it was not necessary for that country to have attended this seminar.

Gentlemen, it has been a pleasure to meet with you.