*M. C. AGARWAL*
*JANAK RAJ MONGA*



# ROLE OF FERTILISERS IN AGRICULTURE:

## A Study of International Experience and Lessons for India

## I

THE world population is increasing at an alarming rate, about 100 persons per minute, 15,000 each day and more than 50 millions a year. At the present rate of increase the population of the world will be more than 6 billions by the end of the present century. This growth in population has come to be regarded as 'Population Explosion'. The 'explosion' would be less serious if all people, *inter alia*, could enjoy a satisfactory diet both quantitatively and qualitatively. Robinson [1] estimates that already some two-thirds of the present population are underfed which means they are suffering from either under-nourishment or malnutrition.

Most population theorists and demographers believe that in the race between growing population and the food supply, the former would win. Sukhatme [2], for instance, concluded that the world food supply would have to be doubled between 1960 and 1980 if reasonably adequate levels of nutrition were to be met. This would require an annual rate of increase in food production of 3·5 per cent throughout that period. Brown stated that if the population of the developing regions of the world expanded by the expected 3,000 million persons at the end of this century, they would need to develop an additional food production capacity equal to current production of

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the entire world. This involves a stupendous task and calls for concerted efforts to equilibrate food supplies and the growing requirements of a fast-multiplying world.

Geographers particularly point out that as far as commercial agricultural development is concerned, the surface of the globe is limited. They estimate that only about 10 per cent of the earth's surface is suitable for farming and two-thirds of it is devoted to major crops. The crucial issue, therefore, is: how to feed and maintain the surging billions of the world with limited resources of sustenance ?

The problem of hunger could be overcome by the extension of food producing acreages or by increasing crop yields. Although the additional acreages would be valuable, in total they would increase the cultivable area by only a slight amount. The only alternative to increase the food supply is, therefore, to increase the yields. Robinson [3] strongly feels that making "two blades of grass grow where one grew before" seems to offer a better prospect for solving the problem. The yield can be increased by enlarging production and use of fertilisers, using better seeds, crop rotation practices, more efficient farm tools and machinery, popularising insecticides, controlling soil erosion and extending irrigational facilities. It is true that agricultural productivity depends upon natural factors but modern technology has reached a point where if strategic inputs are made available and used in appropriate manner, they would boost productivity which might even transcend the natural handicaps.

## II

### ROLE OF FERTILISERS

Fertilisers are the crucial inputs and are regarded as 'Kingpin in Agriculture'. They add to the soil essential nutrients for the growth of plants. As crops are grown, the nutrients get dissipated and their replenishment is necessary to perpetuate production. The nutrients which are primarily taken from the soils are Nitrogen (N), Phosphorus ($P_2O_5$) and Potash ($K_2O$), besides other essential secondary and micronutrients. We can illustrate the point by focusing attention on two major crops, namely, Wheat and Rice. In the case of Wheat it has been found [4] that every 100 kilograms of the grain remove

about 2 to 3 kg. N, 1.4 to 1.6 kg. $P_2O_5$ and 2.5 to 3 kg. $K_2O$. For the Rice, the estimates [5] of nutrients removal suggest a range of 0.6 to 2.4 kg. N, 0.2 to 1.2 kg. $P_2O_5$ and 0.4 to 3.7 kg. $K_2O$ depending upon numerous varieties of Rice and different environmental conditions.

Fertilizers also play a significant role under intensive agriculture which is the only feasible alternative in a world tormented by the scarcity of cultivable land. Ibach (1966) estimated [6] that in the U.S.A. one ton of NPK would substitute for 9.4 acres of land at the 1964 average crop and fertiliser price level. In India where the average fertiliser application is very low, one ton of Nitrogen can substitute for 20 to 25 hectares of land under unmanured Wheat or Paddy (cleaned as well as uncleaned rice).

Moreover Fertiliser use improves labour productivity on farms. For instance, the overhead labour costs on land, tillage, irrigation, weed control and seeding will not usually vary according to output. The use of fertilisers would yield a benefit in terms of unit labour cost when output expanded.

Fertilisers also improve output per hectare under High Yielding Varieties (HYV) which have shown quite remarkable responses to Nitrogen. In the case of Rice, the HYV registered a production of 19.22 quintals per hectare for a dose of 40 kgms. of Nitrogen as against 17.9 quintals per hectare for the local best variety. Similarly 24.1 quintals of Wheat was produced per hectare for a Nitrogen input of 20 kgms. as against 13.3 quintals of local best variety per hectare. The disparity becomes all the more glaring when rising levels of Nitrogen doses are studied. For example, with a Nitrogen intake of 160 kgms. per hectare HYV, Rice recorded an output of 11.73 quintals and the local best variety trailed behind at 7.89 quintals. Wheat at a Nitrogen intake of 100 kgms. per hectare stood at 8.4 quintals in the case of HYV and the local best variety lagged steeply behind at a low of 1.8 quintals only. [7]

Finally, the fertilizers have an important role in the irrigation too. It is held that irrigation is an important requirement but it must be noted that it can only provide water, which howsoever important to plant metabolism supplies only a single plant nutrient namely, hydrogen. The provision of supplemental irrigation water in effect amounts to supplying increased quantities of balanced fertilisers if the

water is not to be wasted [8].

Crop yields are miraculously stepped up through the use of fertilisers. Demonstrations and trials, conducted by United Nations Organisation under 'Freedom From Hunger Programme', at farm lands in three regions of the world viz., W. Africa, the Far East and N. America and Latin America have revealed a weighted average increase of 54 per cent in output of all crops through the use of best varieties of fertilisers [9]. The details of demonstrations and trials in selected countries under the same programme are given in tables I to III.

## III

### INTERNATIONAL EXPERIENCE—A STUDY OF SELECTED COUNTRIES

Fertiliser consumption in different regions of the world has shown a phenomenal growth in recent years. This has been substantiated by the data given in table IV which bears out this fact adequately. A similar trend is discernible in certain selected countries of the world. We have here attempted a selective study to establish a relationship between the Fertiliser consumption and the Total agricultural production, instead of only the food production, since the data pertaining to crop-wise consumption of the fertilisers is not available. To make the procedure easy, the indices have been computed for both the variables taking the average of the period 1952-56 as the base period. The countries selected are Belgium, Netherlands, United Kingdom, United States, Israel, Japan and Australia each representing a different level of consumption.

Table V shows that the use of fertilisers in Belgium, Netherlands, U.K., U.S.A., Israel, Japan and Australia has increased from 10 per cent (Israel) to less than 200 per cent (U.S.A.) over a period of ten years. The experience in fertiliser consumption of these countries has highlighted a significant relationship between fertiliser input and crop output. In fact in developed countries, the increased agricultural production and high yields are closely related to the high doses of fertilisers. We have described this relationship by calculating a measure of correlation between the indices of aggregate fertiliser consumption and the indices of total agricultural output and a significant coefficient has been found between the doses of fertilisers and agri-

cultural production. In certain cases the correlation is so perfect that any change in the doses of fertilisers will have a corresponding change in the output. If a trend line is drawn by applying $Y=a+bx$, almost all the points will lie on it. This is true especially of countries like Belgium, U.K., Israel, Japan and Australia though a high degree of relationship can be seen for Netherlands, U.S.A. and Belgium.

## IV

### LESSONS FOR INDIA

The causal investigation attempted in the foregoing section unfolds certain useful lessons for India. Being predominantly a farm-based economy, tortured by recurrent food deficits and even a declarating farm productivity, wasting precious foreign exchange on food imports, India would do well to augment farm output via improved productivity and increased fertiliser intake. It may be amusing to note that India has got a high potential for fertiliser use. Table VI shows that a paddy yield of upto 12572 kgms. per hectare could be achieved by the use of fertilisers in India. This is in refreshing contrast with country like Japan so well noted for its rice yields. During 1967-68, the average yield of high yielding wheat varieties was 47.3 quintals per hectare in Ludhiana district (of Punjab), a figure approaching the yield in the Netherlands, which has the world record.

India has the conceivable distinction of having the lowest per hectare yield of every crop she grows. The present low yield is explained by the fact that, "centuries of exploitation of land by continuous cropping without corresponding replenishment of plant nutrients so removed has made the soils infertile and unproductive."[10] With already 45 per cent of the total land under cultivation which is the highest in the world, the Indian farmer is left with no alternative but to increase the productivity.

Soil tests in India indicate that almost all the soils must have additional Nitrogen, about 85 per cent of the soils need additional potash, if crop yields are to be increased by 50 to 100 per cent. The only way is chemical fertilisers which alone can raise the productivity by 35 to 50 per cent. Indian farmer is accustomed to the use of organic nutrients such as farm yard manures, green manures, compost, sewerage etc.

A great lacuna of these manures is that the nutrients in them form only a small proportion of the weight. Moreover the required proportions needed for different crops and under different conditions is also not satisfactory and it may take many tonnes per hectare of such manures to make good the drains of the nutrients caused by a single crop with the result that the needs for modern agriculture are not met.

Since independence and more particularly after the inauguration of the economic planning the use of chemical fertilisers has witnessed a continuous rise, though levels have been none too satisfactory. This fact has been given due attention in laying down the targets for the Fourth Plan, the draft of which says :

"Recent years have witnessed a spurt in the consumption of chemical fertilisers. The estimated annual consumption on the eve of the fourth plan is 1.40 million tonnes of N, 0.40 million tonnes of $P_2O_5$ and 0.18 million tonnes of $K_2O$. It has been anticipated that the requirement of chemical fertilisers at the end of the fourth plan will be 3.70 million tonnes of N, 1.80 million tonnes of $P_2O_5$ and 1.10 million tonnes of $K_2O$."[11] The projection of the future consumption needs of fertilizers have been arrived at by the Fertilizer Association of India. The average demand based on various methods during the Fourth Plan is presented in Table VII.

*Level of Consumption.* The total consumption of fertilizers in a country may not satisfactorily represent the intensity or level of consumption per hectare of arable land. In India, for instance, the increase in the fertiliser nutrients is no doubt significant, the level of consumption continues to be much lower than many advanced as well as developing countries. In other words, she is still one of the lowest per hectare consumer of the fertiliser nutrients whereas the loss of the soil fertility is the same all over the world. This is shown in Table VIII.

It will be observed from Table VIII that the Indian consumption of fertilisers is lower by about 99 times than that of Netherlands, 50 times that of Japan and is also lower than even smaller nations like U.A.R. and Israel. Recent data suggest that the consumption of nitrogenous fertilisers has shown a significant lag. The various plan targets had not been achieved. The Estimates Committee [12] noted that this lag was high at 69 per cent during the First Plan. Although it shrank to 57 per cent during Second Plan, the progress was, by no

means, satisfactory and the sad tale was spalled over the Third Plan period as well.

Furthermore, in India, the fertiliser consumption is not uniform in all the states/union territories. The Estimates Committee [13] found that the farmers in southern region are more fertiliser minded than their counterparts in other regions. In 1965-66, 11 states[14] out of 24 states/union territories consumed 83 per cent of All-India consumption whereas the remaining states/union territories only accounted for 17 per cent. This underlies a systematic study of regions where fertiliser use is deficient so that steps may be taken to lessen the regional imbalances in this area.

*Impact of Fertiliser Application.* As has been done in the case of certain selected countries of the world, the impact of fertiliser use could be ascertained by computing a measure of relationship between fertiliser consumption and crop yields or from output. Unfortunately such a measure may not yield dependable results in the case of India because certain supplemental circumstances so essential to gauge the success of a fertiliser programme are non-existent here. Moreover the fertiliser supply is restricted and a uniform distribution of it throughout the country would only have an effect of thinning down the per capita intake. This would indicate a relative failure of the fertiliser programme. A better approach in our circumstances shall be to select those areas where intensive doses of fertilisers have been administered and other supplemental inputs have been ensured within a suitable framework in order to find out the fertiliser response to output. The Intensive Agricultural Development Programme (IADP),[15] commenced from 1960-61, may provide us a basic data for our causal investigation in India.

*Fertiliser Responses.* A number of trials have been conducted to study the responses of crops to fertilisers and results have been publicised to orient the farmers to a vigorous fertiliser use. A recent study on this subject by M/s. Sucha Singh and N. S. Randhawa deserves quotation here. The authors have shown by a straight line trend applying $Y=a+bx$, the direct relationship between the Fertiliser Consumption and the Food grain production (in respect of Maize, Wheat, Rice and Bajra) in Punjab for a period 1962-63 to 1967-68. A graphical representation of these results shows that a very high degree of positive correlation (0.98) exists between fertiliser input and

crop output. Figure I bears out this relationship clearly.

## V

### TOWARDS A MORE EFFECTIVE FERTILISER PROGRAMME

Our discussion so far has led to the conclusion that fertilisers constitute an input of considerable significance for a breakthrough in the Indian agriculture and for ushering in the green revolution. We learn that in India fertilisers are applied both to food as well as non-food crops. A series of studies [16] conducted during the Second Five Year Plan period reported that approximately 75 per cent of the total consumption of nitrogenous and phosphatic fertilisers was applied to food grains. In 1965, the report of the Shivaraman Committee on fertilisers had estimated that foodgrains would require 70 per cent of the total nutrients by 1970-71 based on cropped area and recommended doses. This estimate was made before the introduction of High Yielding Varieties and the new strategy of intensive cultivation. On the basis of more recent experience, the Fourth Plan Working Group (revised) estimate is that food grains would require 80 percent of the total nutrients by 1973-74. The Estimates Committee [17] reported that the additional production on account of fertilisers by the end of the Fourth Plan would be about 40 per cent of the total additional production.

The first major task in this connection would be to combat the inadequate availability of fertilisers in India. We have earlier noted (vide table VII) that our requirements of NPK would be about 3.22 million tonnes for the year 1969-70 and over the next five years they are likely to grow up to a level of 6·61 million tonnes. As against this the corresponding production targets for the Fourth Plan period are 5.5 million tonnes of capacity and 4.5 million tonnes of production of N, $P_2O_5$ by 1973-74 (Potash is totally an imported input.). These targets would suggest a leeway between consumption requirement and output of fertilisers with a corresponding increased reliance on imports. The leeway would tend to widen if the percentage achievement (in terms of actual production) of the production targets for the Third Five Year Plan is taken into account. As against 110 per cent achievement in the case of N and 65 per cent in the case of $P_2O_5$ in 1961-62, the achievement levels tappered off to 30 per cent and 24

per cent respectively in 1965-66. Table IX testifies to it. If these short falls in output persist over the Fourth Plan Period, the gap between requirements and availability will accentuate unless imports are correspondingly stepped up to make up the lag. A first step in this direction, therefore, would be to augment the domestic production of fertilisers nutrients. As an important plank of this programme, dependence on the imports will have to be curtailed sizeably because they involve higher costs in terms of ocean freight, import duties on plant components, cost of non-productive site facilities, high interest burden and teething troubles and mechanical breakdowns.[18] The Governmental vacillation in sanctioning projects has to be overcome. Steps may be taken to encourage foreign collaboration so that our existing technology gap in this field may be squarely met. Unfortunately the recent developments appear to wean away foreign collaborators from investing in our fertiliser industry due to lincensing intricacies, more lucrative imports in view of falling international prices in a market having a supply lag and a keenly felt demand. Besides, steps must be taken to ensure a fuller availability of an increasing output of fertilisers to the cultivators at relatively low cost. For this purpose improved distributional arrangements, easier availability of credit to purchase fertilisers and even subsidies to medium and small sized farms may be envisaged.

In order to make the fertiliser programme more effective a few of the preliminaries are held to be extremely essential. In the first instance demonstrations should be more extensively given rather than simply confined to IADP districts. It would be better in this connection if instead of segregating the demonstration farms trials are organised on the very plots of the farmers concerned. Such plots may be split into two parts, one with fertiliser intake and another without it. This would bring home to the cultivator the crucial importance of the fertilisers in both output and productivity. Further, the availability of other inputs such as HYV, extended irrigation, improved implements etc. must also be made available at reasonable cost. In this connection the findings of the Estimates Committee are very relevant : [19]

"The best results in production with fertiliser input are achieved only when a proper use is also made of so related inputs. The success of the Fertiliser Promotion Programme will depend to a considerable extent on the promotion of the adoption of recommended pack-

age of practices by the cultivators."

The fertiliser programme would fructify only if the farmers are adequately trained in making proper use of the fertilisers and in arriving at judicious nutrients mixes in keeping with very requirements of crop and soil. For example, certain crops are responsive to high doses of N alone with little of $P_2O_5$ and $K_2O$, while others require an equal proportion of all the nutrients. A carefully conducted soil analysis is germane to the entire fertiliser programme. Soil analysis may be based on samples drawn from time to time in order to determine their fertility levels. Soils are tested in the laboratories and then recommendations are made on the basis of the analysis. And also the time and methods of fertiliser application are indicated. In this country it is reported, that 24 soil testing laboratories were set up under the USAID assistance during the period 1955-60; 10 were set up under IADP and 16 were set up by the state Governments in the course of Third Five Year Plan. In the previous Fourth Plan Draft (1970-71), a proposal to set up 26 new soil testing laboratories was incorporated. The department of agriculture has also introduced mobile soil testing laboratories. The progress is, however, not adequate because the existing facilities cannot fully cope with the existing strains.

## VI

### CONCLUSIONS AND FINDINGS

In this study we have attempted to expose the basic handicaps which currently beset an agricultural resurrection of our economy. We have suggested that the curse of a stagnant farm output could be overcome by boosting productivty and have demonstrated that a high degree of positive correlation exists between fertiliser consumption and agricultural production. We have also arrayed international evidence in support of this relationship and have worked out correlation coefficients for selected countries of the world. It is now common knowledge that a more concerted drive to popularise the use of fertilisers must be launched. Output and availability must be increased and reliance on imports reduced so that precious foreign exchange is conserved. It would be in the fitness of the things if the farmer is trained in a scientific use (as against a hit-or-miss approach) of different

nutrient-permutations. Expansion of soil testing facilities might go a long way in furthering the cause of this scientific approach to fertiliser application.

*REFERENCES*

[1] Robinson, H. — Economic Geography, Macdonald and Evans London (M and E Handbook Series), 1968, p. 66.
[2] United Nations Industrial Development Organisation—Fertilizer Manual 1967.
[3] *Ibid*, p. 68.
[4] Indian Council of Agricultural Research, New Delhi — Indian Farming, March 1968 p. 16.
[5] Indian Farming, *op. cit.*, p. 21.
[6] Kanwar, J. S., 'Fertiliser—The Kingpin in Agriculture— Indian Farming,' *op. cit.*, p. 7.
[7] Indian Farming, *op. cit.*, 7.
[8] Ranganathan, C. R., Mobilizing Fertiliser Inputs to Increase Food Production: The Indian Journal of Public Administration, July-Sept. 1967, p. 493.
[9] Estimates Committee (1967-68): Forty-Ninth Report (Fourth Lok Sabha), Lok Sabha Secretariat, New Delhi. "Fertilisers", p.12.
[10] Seetharman S., Food, Population and Fertilisers: Explosion Hunger, 1975. 1969 I (New Delhi) p. 33.
[11] Planning Commissin, Government of India — Fourth Five Year Plan 1969-74 Draft, p. 121.
[12] *Ibid*, p. 15
[13] *Ibid*, p. 15
[14] 11 states are U.P., Andhra Pradesh, Madras, Maharashtra, Punjab, West Bengal, Bihar, Mysore, Gujarat, Madhya Pradesh and Orissa.
[15] The genius of the programme was 'a simultaneous, coordinated package of related farming practices would be most effective in increasing farmer's yields. These practices included the use of better seeds, treating and cleaning them for protection against diseases, improved implements to prepare seedbeds more effectively, fertilisers at the right time and in the right amounts, applying irrigation more effectively and taking control and preventive measures against insect pests'—Shastry, B. D.: Package Programme, Illustrated Weekly of India, A Times of India Publication, Bombay, May 11, 1969, p. 34.
[16] Cummings Jr., R. W. and Ray, S. K., The New Agricultural Strategy, Economic and Political Weekly, Bombay, March 29, 1969, p. A-9.
[17] *Ibid*, p. 13
[18] For details refer to John, K. John: Towards Cost Reduction, Commerce, Bombay, Annual Number 1967, p. A-80.
[19] *Ibid*, p. 16.

TABLE I

*Results of Fertilizer Trials and Demonstrations on Wheat, Rice and Maize: Selected Countries*

*WHEAT*

| *Country (a)* | *Fertilizer treatment $N$-$P_2O_5$-$K_2O$ Kg. per hectare* | *Yield, (in Kg. Per Ha Control* | *Fertilized* | *Yield Kg. per ha.* | *Increase percentage* |
|---|---|---|---|---|---|
| *Lebanon* | | | | | |
| Irrigated | 60 — 60 — 30 | 1905 | 3744 | 1839 | 96 |
| Nonirrigated | 60 — 60 — 0 | 1430 | 3267 | 1837 | 128 |
| *Morocco* | | | | | |
| South | 20 — 40 — 0 | 391 | 944 | 553 | 141 |
| North | 40 — 60 — 40 | 914 | 1541 | 627 | 69 |
| *Syria* | | | | | |
| Irrigated | 60 — 60 — 0 | 1860 | 2802 | 942 | 51 |
| Nonirrigated | 0 — 40 — 0 | 968 | 1181 | 213 | 22 |
| *Turkey—Central Anatolia* | | | | | |
| Irrigated | 60 — 60 — 0 | 1530 | 3010 | 1480 | 97 |
| Nonirrigated | 30 — 30 — 0 | 1401 | 2104 | 703 | 50 |
| *Turkey—Thrace* | | | | | |
| Irrigated | 20 — 40 — 0 | 1543 | 2661 | 1118 | 7 |
| Nonirrigated | 60 — 60 — 0 | 1308 | 2318 | 1010 | 772 |

*Source*—See Table III

TABLE II

*RICE*

| *Country (a)* | *Fertilizer Treatment $N$—$P_2O_5$—$K_2O$ Kg. per hectare* | *Yield (in Kg. per ha). Control* | *Yield Fertilized.* | *Yiled increase Kg. per ha.* | *Percentage.* |
|---|---|---|---|---|---|
| *El Salvador Central* .. .. | 90 — 90 — 90 | 1982 | 4428 | 2446 | 123 |
| *Ghanna* | | | | | |
| Forest .. .. .. | 22.4 —22.4 —0 | 1309 | 1970 | 668 | 51 |
| Savanna .. .. .. | 26.9 —26.9 —0 | 1797 | 3218 | 1421 | 79 |
| *Nigeria* | | | | | |
| Forest .. .. .. | 22.4—22.4—0 | 1869 | 2859 | 990 | 53 |
| Savanna .. .. .. | 22.4—22.4—22.4 | 1289 | 2051 | 762 | 59 |
| *Senegal* | | | | | |
| Casamanc .. .. .. | 90 — 0 —0 | 1218 | 1968 | 750 | 62 |
| Fleuva .. .. .. | 45 — 45 — 45 | 1917 | 2442 | 525 | 27 |
| Sine-Saloum .. .. .. | 90 — 0 — 0 | 603 | 1555 | 952 | 158 |
| *Turkey* | | | | | |
| Central Anatolia .. .. | 40 — 40 — 0 | 3640 | 5280 | 1820 | 53 |
| Thrace .. .. .. | 60 — 60 — 0 | 3545 | 5288 | 1743 | 49 |

*Source*—See Table III

TABLE III

*MAIZE*

| *Country (a)* | *Fertilizer Treatment N—$P_2O_5$—$K_2O$ Kg. per hectare* | *Yield (in Kg.) per ha. Control* | *Fertilized* | *Yield Kg. per Kg. per ha.* | *Increase Percentage.* |
|---|---|---|---|---|---|
| *El Salvador-Central* | 90 —90 — 0 | 2420 | 4146 | 1726 | 71 |
| *Ghanna* | | | | | |
| Forest | 22.4 —0 —22.4 | 1419 | 2287 | 868 | 61 |
| Savanna | 44.8 —0 — 0 | 1159 | 2022 | 863 | 74 |
| *Honduras* | | | | | |
| Hybrid-North | 90 — 90 — 90 | 4788 | 9801 | 5013 | 105 |
| Local | 45 — 45 — 45 | 1674 | 3110 | 1436 | 86 |
| *Morocco-North* | | | | | |
| Irrigated | 40 — 40 — 0 | 1436 | 2395 | 959 | 67 |
| Nonirrigated | 0 — 40 — 0 | 648 | 1053 | 405 | 62 |
| *Morocco-South* | | | | | |
| Nonirrigated | 20 — 40 — 0 | 723 | 1139 | 416 | 58 |
| *Nigeria* | | | | | |
| Forest | 0 — 0 —22.4 | 1521 | 1861 | 340 | 22 |
| Savanna | 0 — 0 —22.4 | 1261 | 1559 | 298 | 24 |
| *Turkey* | | | | | |
| Marmara | 40 — 40 — 0 | 2246 | 3194 | 948 | 42 |
| Black Sea | 40 — 40 — 0 | 2072 | 3788 | 1716 | 83 |

(*a*)—Data by area, variety and irrigated or nonirrigated land included where available.

*Source* :—Food and Agricultural Organisation of the United Nations, Review of Trial and Demonstration Results, 1961-62, 1962-63 and 1963-64 (preliminary), Freedom From Hunger Campaign Fertilizer Programme (Rome 1963, 1964, 1965).

*Note* :—Results shown include only that fertilizer application showing the largest additional return per hectare of crop. In some instance, a different fertilizer application produced a larger increase in Yield, a higher net return per dollar invested in fertiliser or a large output per kilogramme of fertilizer applied.

TABLE IV

*World Consumption of Fertilizer Nutrients and Compound Rate of Increasz*

(000 *M. Tonnes*)

| *Area* | *Fiscal Year* | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Developed Regions* | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 | 1954-64 | 1959-64 |
| Western Europe .. | 7095 | 7552 | 7991 | 8503 | 8926 | 9236 | 9912 | 10004 | 10542 | 11347 | 12149 | 5.5 | 5.6 |
| Eastern Europe .. | 3067 | 3526 | 3668 | 4018 | 4423 | 4801 | 5067 | 5264 | 5497 | 6180 | 6960 | 8.5 | 7.7 |
| North America .. | 5907 | 5887 | 5845 | 6101 | 6251 | 7101 | 7146 | 7564 | 8158 | 9173 | 10011 | 5.5 | 7.1 |
| Oceania .. | 616 | 722 | 762 | 709 | 790 | 760 | 836 | 924 | 969 | 944 | 1229 | 7.1 | 10.0 |
| Others .. .. | 1141 | 1442 | 1599 | 1703 | 1613 | 1899 | 1881 | 2282 | 2099 | 2178 | 2335 | 7.4 | 4.2 |
| Total .. .. | 16826 | 19129 | 19865 | 21034 | 22003 | 23797 | 24842 | 26038 | 27265 | 29822 | 32684 | 7.0 | 6.5 |
| *Developing regions (a)* | | | | | | | | | | | | | |
| Africa .. .. | 114 | 172 | 170 | 172 | 214 | 217 | 235 | 273 | 274 | 297 | 388 | 13.0 | 12.3 |
| Asia .. .. | 490 | 646 | 700 | 851 | 893 | 936 | 1144 | 1361 | 1578 | 1695 | 2024 | 15.2 | 16.6 |
| Latin America .. | 458 | 481 | 570 | 690 | 690 | 719 | 739 | 959 | 965 | 1103 | 1284 | 10.8 | 12.2 |
| Total .. | 1223 | 1299 | 1440 | 1713 | 1797 | 1872 | 2118 | 2593 | 2817 | 3095 | 3696 | 11.6 | 14.5 |
| World Total (*b*) | 17808 | 20428 | 21305 | 22747 | 23800 | 25669 | 26960 | 28631 | 30082 | 32917 | 36380 | 7.4 | 7 2 |

*Source* :—Food and Agricultural Organisation of United Nations, Fertilizers : An Annual Review of World Production, Consumption and Trade 1954-64 (Rome.)

(*a*) Developed countries with in developing regions : Japan, South Aftica and U.A.R.

(*b*) Excluding Mainland China.

TABLE V

*Data Showing Relationship Between Fertilizer Consumption and Agricultural Production, Slected Countries.*

| *Years* | *Belgium* | | | *Netherlands* | | | *United Kingdom* | | | *United Stattes.* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| 1952-53 to 1956-57 .. .. .. | 3327 | 100 | 100 | 4356 | 100 | 100 | 9057 | 100 | 100 | 55746 | 100 | 100 |
| 1957-58 .. .. .. | 2079 | 64 | 103 | 4703 | 108 | 103 | 10238 | 112 | 108 | 59909 | 107 | 99 |
| 1958-59 .. .. .. | 1892 | 59 | 105 | 4668 | 107 | 111 | 10994 | 121 | 107 | 68197 | 122 | 107 |
| 1959-60 .. .. .. | 1831 | 57 | 101 | 4755 | 109 | 110 | 12798 | 141 | 113 | 68562 | 123 | 108 |
| 1960-61 .. .. .. | 1890 | 59 | 115 | 4739 | 109 | 125 | 13389 | 148 | 121 | 70944 | 127 | 110 |
| 1961-62 .. .. .. | 1995 | 62 | 116 | 4701 | 108 | 121 | 13903 | 153 | 122 | 76465 | 137 | 111 |
| 1962-63 .. .. .. | 2240 | 69 | 123 | 5195 | 119 | 133 | 14182 | 157 | 132 | 83320 | 150 | 112 |
| 1963-64 .. .. .. | 4612 | 143 | 130 | 5571 | 128 | 127 | 14858 | 164 | 133 | 95822 | 173 | 118 |
| 1964-65 .. .. .. | 4118 | 128 | 120 | 5440 | 125 | 131 | 14940 | 165 | 140 | 99539 | 179 | 117 |
| 1965-66 .. .. .. | 4454 | 138 | 117 | 5622 | 129 | 128 | 15478 | 171 | 143 | 112762 | 203 | 118 |
| 1966-67 .. .. .. | 4755 | 147 | 118 | 5272 | 133 | 136 | 16452 | 182 | 146 | 127030 | 287 | 118 |
| | r. | .6397 | | r. | .7827 | | r. | .9510 | | r. | .7575 | |

TABLE V—(contd)

| | *Israel* | | | *Japan* | | | *Australia* | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| 1952-53 to 1956-57 .. .. .. .. .. .. .. | 353 | 100 | 100 | 11331 | 100 | 100 | 4609 | 100 | 100 |
| 1957-58 .. .. .. .. .. .. .. | 314 | 89 | 133 | 12404 | 109 | 113 | 5631 | 122 | 100 |
| 1958-59 .. .. .. .. .. .. .. | 316 | 89 | 137 | 15085 | 133 | 118 | 5384 | 117 | 119 |
| 1959-60 .. .. .. .. .. .. .. | 322* | 91 | 169 | 15547 | 137 | 117 | 5864 | 127 | 119 |
| 1960-61 .. .. .. .. .. .. .. | 331 | 94 | 175 | 18439 | 163 | 118 | 6294 | 137 | 124 |
| 1961-62 .. .. .. .. .. .. .. | 363 | 103 | 186 | 16405 | 148 | 120 | 6731 | 146 | 126 |
| 1962-63 .. .. .. .. .. .. .. | 332 | 94 | 204 | 16398 | 145 | 129 | 7239 | 157 | 134 |
| 1963-64 .. .. .. .. .. .. .. | 342 | 99 | 211 | 18427 | 163 | 127 | 7349 | 159 | 139 |
| 1964-65 .. .. .. .. .. .. .. | 372 | 105 | 245 | 18120 | 161 | 132 | 9565 | 207 | 145 |
| 1965-66 .. .. .. .. .. .. .. | 402 | 114 | 255 | 19280 | 170 | 133 | 10863 | 286 | 134 |
| 1966-67 .. .. .. .. .. .. .. | 389 | 110 | 252 | 21200 | 187 | 137 | 11447 | 248 | 153 |
| | r. | .9003 | | r. | .8191 | | r. | .8035 | |

*Note* :—

1. Consumption in OOm tonnes—NPK.
2. Index Numbers of Fertilizer consumption.
3. Index Numbers of Total Agricultural production.

r= Coefficient of Correlation

*Figure Assumed.

*Source* :— United Nations, Food and Agricultural Organisation, Production Year Books.

TABLE —VI

*Data for Paddy Yields Obtained by the Winners of the farmers contests*

| *Country* | *Yield in Kg./ha.* |
|---|---|
| India .. .. .. .. .. | 12572 |
| Phillipines .. .. .. .. | 12500 |
| Japan .. .. .. .. .. | 11936 |
| Taiwan .. .. .. .. .. | 8725 |

*Source* :—Fertiliser Guide for Tropical and Subtropical farming, Zurich, Switzerland (1967) p. 31.

TABLE — VII

*Projected Demand of the fertilisers during the Fourth Plan Period*

*(million tonnes)*

| *Years* (1) | *N* (2) | $P_2 O_5$ (3) | $K_2 O$ (4) | Total (5) |
|---|---|---|---|---|
| 1969-70 .. .. .. .. | 1·84 | 0·92 | 0·46 | 3·22 |
| 1970-71 .. .. .. .. | 2·29 | 1·14 | 0·57 | 4·00 |
| 1971-72 .. .. .. .. | 2·74 | 1·37 | 0·69 | 4·80 |
| 1972-73 .. .. .. .. | 3·23 | 1·61 | 0·81 | 5·65 |
| 1973-74 .. .. .. .. | 3·78 | 1·89 | 0·91 | 6·61 |

*Source* : Fertiliser Association of India: Report on the development of Fertiliser Industry during the Fourth Plan Period. p. 5.

Note :The calculations have been made by taking the average of total nutrients in each year and spreading it in the proportion of N: $P_2 O_5$ : K O as 4:2:1.

TABLE —VIII

*Fertiliser Consumption Per Hectare of Arable Land in Different Countries*
1962-63—1966-67

(*Kgms.*)

| | *Years* | | | | |
|---|---|---|---|---|---|
| Country .. .. .. | 1962-63 | 1963-64 | 1964-65 | 1965-66 | 1966-67 |
| Netherlands .. .. .. | 518·46 | 563·86 | 556·79 | 580·79 | 610·15 |
| Belgium .. .. .. | 446·08 | 532·31 | 500·52 | 474·84 | 520·25 |
| Germany West .. .. | 304·32 | 311·61 | 327·98 | 348·80 | 335·10 |
| Japan .. .. .. | 270·06 | 297·68 | 304·39 | 321·12 | 353·57 |
| China (Taiwan) .. .. | 189·99 | 210·81 | 237·07 | 255·84 | 269·98 |
| United Kingdom .. .. | 193·69 | 206·52 | 199·94 | 205·16 | 221·28 |
| Austria .. .. .. | 202·59 | 190·40 | 195·38 | 203·19 | 211·33 |
| Koria (Rep. of) .. .. | 270·06 | 176·85 | 167·52 | 149·15 | 184·81 |
| France .. .. .. | 122·41 | 135·46 | 146·23 | 148·14 | 164·54 |
| U.A.R. .. .. .. | 94·83 | 95·98 | 110·17 | 114·09 | 110 07 |
| Israel .. .. .. | 85·34 | 84·82 | 93·32 | 101·95 | 97·01 |
| Italy .. .. .. | 56·81 | 56·53 | 61·71 | 71·02 | 72·83 |
| U.S.A. .. .. | 45·00 | 51·59 | 54·49 | 59 62 | 70 63 |
| U.S.S.R. .. .. .. | 11·95 | 14·04 | 19·39 | 24·45 | 25·83 |
| India .. .. .. | 3·46 | 3·68 | 4·13 | 4·97 | 7·62 |

*Source* :Fertilizer Association of India: Fertiliser Statistics 1964, 1965, 1966, 1967 and 1968.

*Note* : Fertilisers = $N + P_2O_5 + K_2O$

TABLE—IX

*Production Targets and Actual Production of N and $P_2O_5$ Attained During the Third Plan*

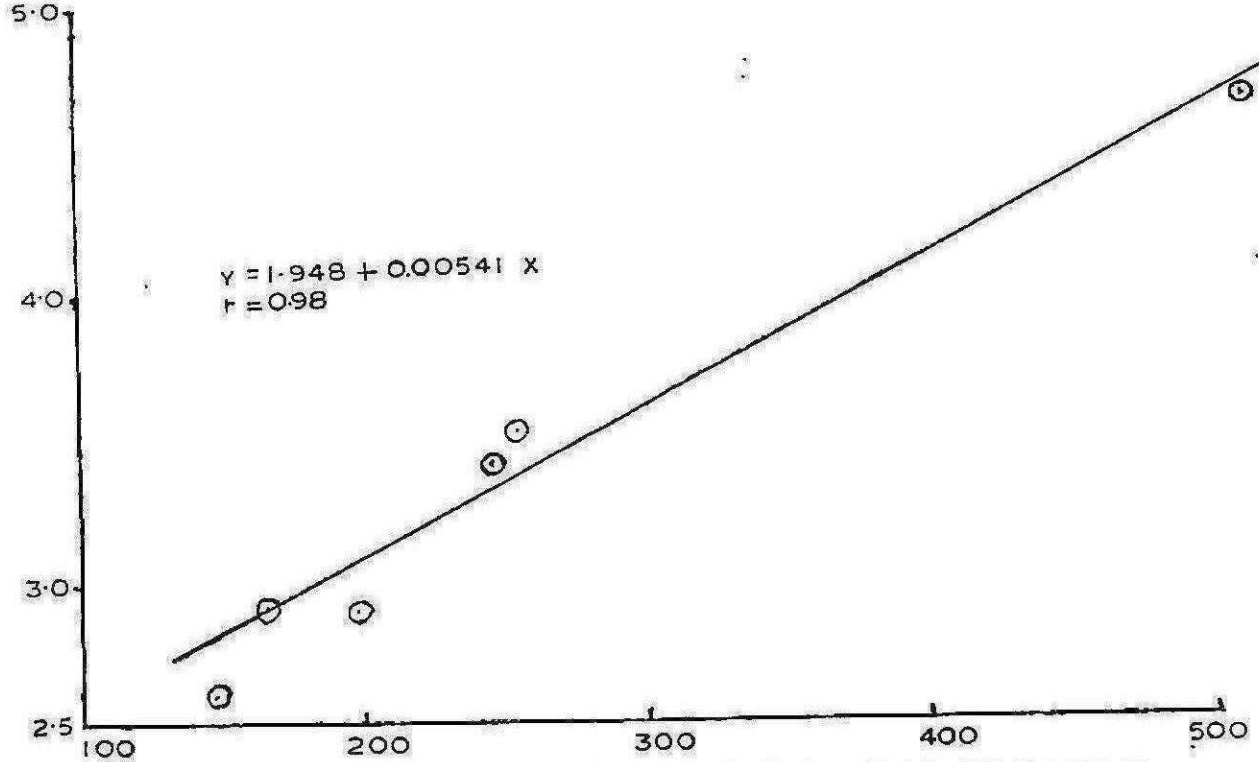
| Years | Production Target | | Actual Production | | Percentage Achievement of Production | |
|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | N | $P_2O_5$ | N | $P_2O_5$ |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | (Metric Tonnes) | | | | | |
| 1961-62 | 1,40,000 | 1,00,000 | 1,54,326 | 65,360 | 110 | 65 |
| 1962-63 | 2,00,000 | 1,50,000 | 1,94,194 | 68,300 | 97 | 59 |
| 1963-64 | 3,00,000 | 2,25,000 | 2,19,072 | 107,836 | 73 | 48 |
| 1964-65 | 5,00,000 | 3,00,000 | 2,43,230 | 131,021 | 49 | 44 |
| 1965-66 | 8,00,000 | 5,00,000 | 2,37,889 | 118,779 | 30 | 24 |

Capacity Targets and Actual Capacity of N and $P_2O_5$ created during the Third Plan

| Year | Capacity (Metric Tonnes) | | | | Percentage Achievement of Target | |
|---|---|---|---|---|---|---|
| | N | | $P_2O_5$ | | N | $P_2O_5$ |
| | Target | Actual | Target | Actual | | |
| 1961-62 | 4,00,000 | 246251 | 1,50,000 | 95,636 | 61 | 64 |
| 1965-66 | 10,00,000 | 586000 | 5,00,000 | 266,350 | 59 | 53 |

*Source* : Fertiliser Association of India: Fertilizer Statistics 1962, 63, 64, 65, and 66.

FIGURE 1




Relationship between Fertiliser Consumption & Food Production—(Panjab—1962-63 to 1967-68)