Fertilizers in the Indian agricultural economy hardly need any emphasis. All the important and leading studies in Indian agricultural economics have impressed upon the fact that India can increase agricultural production only through intensive agricultural techniques. Among the different intensive agricultural techniques, fertilizer use is the most important one.

In 1985-86, India used about 9 million metric tonnes (mmts) of nutrients in the form of chemical fertilizers. The Seventh Five Year Plan has aimed at raising it to 13.5 to 14 mmts by 1989-90. The consumption has to reach about 20 mmts by the year 2000 to achieve the need-based targets of agricultural production.

The past growth in fertilizer use in India is no doubt very much impressive (vide table: 3.2). India now ranks fourth in the total fertilizer consumption after U.S.A., the U.S.S.R. and China. Its record in raising fertilizer use to about 50 kilograms per cultivated hectare in less than four decades also compares quite favourably with many countries. However, still
India needs further increase in fertilizer consumption for the following reasons:

1. India needs substantial additional agricultural production to meet the basic necessities of a large and growing population. It is projected that India will have 935 million of population in 2000 A.D. Consequently, within a period of 25 years, the foodgrain requirements of the country would be more than double. To attain this production target, it would be necessary to improve the per hectare yield by various intensive agricultural methods.

2. A rapid generation of agricultural surpluses is required for economic development in general and to meet the increasing demand of agro-based industries in particular. In view of falling land-man ratio, substantial growth in fertilizer use is an imperative.

3. The pressure on land is continuously increasing. Available statistical information (NCA, 1976) portrays the picture as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Per capita arable land</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-71</td>
<td>0.28 hac.</td>
</tr>
<tr>
<td>1985</td>
<td>0.22 hac.</td>
</tr>
<tr>
<td>2000 (expected)</td>
<td>0.17 hac.</td>
</tr>
</tbody>
</table>
Thus, in course of time per capita arable land is found decreasing. Moreover, with the development of any economy, its (land) demand for civic uses, industries, roads, housing, etc., increases. Thus, in India the pressure on land in the coming years would be tremendous. Hence the only alternative to attain the required high level of agricultural production lies in the intensive use of land at an increasing rate.

4. Since long, wide spread deficiency of nitrogen in Indian soils is well-known. The availability of phosphorous and potash is also low (Tandon 1976). Besides, the evidence on deficiencies of sulphur and micro nutrients at a growing number of locations is accumulating (Randhawa and Tandon 1982).

5. The need for further growth in fertilizer use is also the outcome of the very high dependence of New High Yielding Varieties Programme (HYVP) on fertilizers. This is obvious from the experience of cultivating HYVs on irrigated land. The complementarity between HYVs and the judicious use of fertilizers on unirrigated land is also well accepted. Low fertility of soils works as severe a constraint as any other in promoting technological change on unirrigated land. If efforts are not made to raise fertility on unirrigated land through the judicious use of fertilizers, farmers would not have any incentive to invest in dryland technologies irrespective of their form and content (Tandon 1981).
6. Chemical fertilizer is one of the most important sources of plant nutrients. Of course, the productivity of land depends on many factors besides the availability of plant nutrients. But world over, the experience suggests that chemical fertilizers have become increasingly important in removing soil fertility constraints and continuously raising land productivity through facilitating technological change. In this respect, China is a very good example (Stone 1986). China's fertilizer consumption was found to be 18 mmts against India's 9 mmts in 1985-86. Both were almost on par using less than one lakh tonnes in the early 1950s.

7. India is lagging far behind in fertilizer consumption per hectare of arable land when compared with other countries. This is shown in the following table:

| TABLE: 1.2 |
| Fertilizer use in Selected Countries during 1984-85 |
|-----------------|-----------------|-----------------|-----------------|
| Country         | Arable land     | Fertilizer use  | Yield per hectare (kg) |
|                 | (in million    | (kg/hac, or     | Rice | Maize | Sugarcane |
|                 | hectares)       | arable land)    |      |       |           |
| Egypt           | 2.3             | 363.9           | 5,479| 4,424 | 79,478    |
| China           | 97.4            | 180.6           | 5,346| 2,546 | 70,006    |
| U.S.A.          | 187.9           | 104.1           | 6,095| 7,406 | 82,036    |
| U.S.S.R.        | 227.7           | 98.8            | 3,898| 2,906 | --        |
| India           | 164.8           | 39.4            | 2,179| 1,207 | 59,845    |

In the above table, the countries with scarcity of land as well as those with abundance of it show a very high level of fertilizer consumption which is, of course, associated with high productivity.

All the above points justify the need for rapid future growth in fertilizer consumption in India. Therefore, the pertinent question concerning the future is how to raise fertilizer consumption. This point has been well brought out by Desai Gunvant M. (1986, p. 248) - a known economist on fertilizer. The issues raised by him can be briefly, put as under:

(a) As per the target, fertilizer consumption has to increase from 9 mmts in 1985-86 to about 14 mmts by 1989-90. This implies an annual increment of more than one mmt in consecutive years. As against this, till 1985-86 in India the annual growth in fertilizer consumption has exceeded one mmt only once.

(b) The two major forces behind the past growth in fertilizer consumption have weakened. Firstly, the bulk of the past growth in fertilizer use was the outcome of diffusion of fertilizer use on irrigated land. Secondly, upward movements in the rates of application was due to the replacement of local varieties by HWs.

(c) All the relevant evidences suggest that both fertilizer use and HWs have spread to virtually all the irrigated land and the rates of application have also reached a fairly high level.
(d) A handsome amount in the form of subsidy was provided on some nutrients. This played an important role in the past fertilizer use. In just three years between 1982-83 and 1985-86, the subsidies on food and fertilizers have gone up from Rs. 1,316 crores to Rs. 3,700 crores. The scope of stimulating fertilizer consumption through subsidising fertilizer use seems thus to be very much limited (Singh V.P. 1986).

**Importance of Fertilizers:**

Since long fertilizer use has been recognised as one of the central elements in the production plans by various commissions appointed to study the different aspects of agricultural economy of India. These include: the Report of the Famine Inquiry Commission (1945); The Report of the Royal Commission on Agriculture (1928); etc. etc.

A study by Menon V.S. (1956) very enlightening on the role of various fertilizers in crop production in India which is again based on a number of studies completed in various parts of the country. His important conclusions have been put up as under:

** The responses of nitrogeneous fertilizers in respect of each of the cereals work out to about 2.5 mds of additional foodgrains per acre with a dosage of 20 lbs. of nitrogen (100 lbs. of ammonium sulphate) per acre which varies with the adequacy of water supply and change in soil type.
** The responses to 20 lbs. of phosphate applied to an acre of land varied from 1 to 2 mds. from crop to crop and with types of soils.

** The additional production by the application of 40 lbs. of potash to an acre as muriate of potash was reported to be about 2.6 mds. per acre in the case of paddy and 3.2 mds. per acre in the case of maize in Bihar.

The important issues emerging from the above discussion can be laid down as:

1. Fertilizers play a leading role in determining the level of agricultural production.
2. Compared to other countries the level of fertilizer consumption in India is low.
3. India needs substantial increase in fertilizer consumption in the years to come.
4. The task ahead of increasing fertilizer consumption in future is a great challenge to all concerned with the agricultural as also industrial development in India.

All these issues indicate that there is a strong case for increasing fertilizer use in India. Therefore, it is pertinent to examine the scope for further increase in fertilizer use by introducing suitable changes in the present fertilizer development policy. To suggest such a strategic policy a
critical look at the past fertilizer policy is imperative for, it would provide a right signal to the new fertilizer development strategy. A plan-wise review in this direction follows here. It is presented in terms of important points of observations.

FERTILIZER DEVELOPMENT POLICY DURING THE PLAN PERIODS:

First Plan: 1951-52 - 1955-56:
1. A substantial increase in fertilizer consumption was envisaged.
2. Improvement in fertilizer distribution system was recognised.
3. The use of chemical fertilizers with manures was stressed.
4. The use of P₂O₅ through subsidy was encouraged.

Second Plan: 1956-57 - 1960-61:
1. It was proposed to improve the fertilizer distribution system through:
   (i) the establishment of more fertilizer depots.
   (ii) raising adequate buffer stocks for various fertilizer nutrients and
   (iii) encouraging fertilizer distribution at a village level by co-operative societies.
2. Information diffusion with respect to the scientific use of fertilizer was recognized.
3. Green manuring use of oilcakes and other manures were promoted.


1. Fertilizer Distribution Enquiry Committee (FDEC) was established.

2. Central Fertilizer Marketing was proposed to deal with the problems of increased fertilizer supply.

3. Balanced fertilization and improved distribution system through use of fertilizers in mixtures form were recognised.

4. Measures in respect of special credit provision for small cultivators were undertaken.

5. States were asked to account for the above considerations while framing their own regional fertilizer development plan.

Fourth Plan: 1969-70 - 1973-74:

1. The expansion of retail trade in fertilizers was encouraged.

2. Balanced fertilizer use through increased use of $P_{2}O_{5}$ and $K_{2}O$ was encouraged.

3. The importance of soil testing laboratories to raise the demand for fertilizer was recognised and measures were taken to expand the network of such laboratories.
4. The shortcomings of soil testing laboratories were recognised and attempts were undertaken.

5. The role of state extension agency in creating demand, for fertilizer was recognised.

6. Fertilizer industries were asked to step up their extension services.

7. Increased use of manures was promoted.

8. Fertilizer use in the cultivation of non-foodgrain crops was encouraged.

9. Fertilizer use in dry-farming areas was encouraged.

10. Measures were taken to remove the acidity and alkalinity of soils.

11. The efficient use of fertilizers was recognised.

Fifth Plan: 1974-75 - 1978-79:

1. To strengthen the distribution of nutrients the steps were taken in the following directions:
   (i) co-operative retailing was emphasised;
   (ii) development of rail transport was encouraged;
   (iii) wholesale points were strengthened;
   (iv) proposed part to bulk shipments of various nutrients;
   (v) at the port the capacity for handling bulk fertilizers was increased.

2. It was proposed to substantially expand the soil testing laboratories for the scientific use of fertilizers.
3. Strengthening of the existing laboratories along with improvement in their utilisation was emphasised.

4. The role of the public sector, the co-operative sector and the private sector was further emphasised in the direction of extension services.

5. The functions viz., to organise transportation, port handling and to co-ordinate allocation of fertilizers were proposed to the central Fertilizer Pool.

Sixth Plan: 1980-85:

1. Attempts were made for equitable and efficient fertilizer distribution system through: increased port handling capacity, use of roads apart from rail-roads, movement of bulk fertilizers near the consumption centres, opening of additional storage depots, increasing the number of retailers, credit provision, introducing multi-agency competition, providing the cost of transportation of all fertilizers from all the rail-heads upto all block headquarters, etc.

2. It was decided to develop the extension facility for encouraging balanced fertilizer use.

3. Attempts were made to strengthen, expand and improve the soil testing facilities throughout India.

4. The use of manures and bio-fertilizers were encouraged.

5. Fertilizers use in dry-farming regions was emphasised.
6. The waste of nutrients while their applications at farm level was noted and the necessary steps to remove it was taken up.

7. Attempt was made to ensure benefits of fertilizer use to the small and marginal farmers.

8. Reduction in regional disparities in fertilizer consumption was recognised.

Seventh Plan: 1985-86 - 1989-90:

1. Attempt has been made to ensure easy availability of fertilizers by encouraging more sale points and improving and expanding port handling capacities.

2. It was proposed to expand the extension services for scientific use of fertilizers.

3. Intensification of soil testing facilities was emphasised.

4. The use of organic and biological wastes was encouraged.

5. Continued emphasis towards development of bio-fertilizers and manures at a field level was emphasised.

6. It was proposed that a special project is established to increase fertilizer use in rain-fed areas.

7. Special attention has been paid to raise fertilizer use in the eastern states with removal of fertilizer development constraints there-in.

8. The removal of regional disparity in fertilizer consumption was emphasised.
9. Promotional efforts in remote areas were allowed to continue in remote areas.

In general, the whole fertilizer development policy since independence can be briefly evaluated into three parts viz., (i) which problems constrained its achievements, (ii) what are the achievements of this policy, and (iii) what are its drawbacks?

All these constituents of the evaluation framework are presented in the forthcoming discussion.

Constraints:

A critical view of fertilizer development policy across plans clearly indicate many changes over time with respect to different aspects of fertilizer use. These steps are in the direction of removing the constraints in the growth of fertilizer use in the successive plans. In this context the three pertinent questions are raised here. They are:

(i) which were the constraints faced by fertilizer development policy in the past?

(ii) how far did fertilizer development policy succeed to overcome the various constraints over time? and

(iii) is there any scope to raise fertilizer use in future by removing the constraints on fertilizer?
Against the background of these issues various fertilizer development constraints are analysed below:

1. Till the end of the fourth plan the country observed a very low level of fertilizer production of all nutrients (vide table: 1.3) accompanied with the occasional shortage of various nutrients in the international market. The review of the fourth plan pointed out that in the second half of the fourth plan one of the major reasons for lower fertilizer use was a significant inadequacy of supplies resulting mainly from shortfall in indigenous fertilizer production and the non-availability of it in the international market (Fifth Plan, 1976, J.). Presently, this constraint exists no more as our fertilizer development policy has succeeded to raise production of various nutrients significantly by now (vide table: 1.3).

2. Needless to say that irrigation facility is an important determinant of fertilizer use. Between 1951-52 to 1967-68, the share of gross irrigated area to gross sown area for India as a whole, ranged between 17.4 per cent to 20.3 per cent which increased to 30.1 per cent in the year 1982-83 (FAI: 1985-86). Thus the poor performance on irrigation front coupled with frequent occurrence of droughts adversely influenced the fertilizer use in the past (Bansil, 1977). Yet at present, it is evident that a large part of GCA is without irrigation facility. Hence, with the expansion of area under irrigation in India stands
good chances to raise the present level of fertilizer consumption.

3. High-yielding varieties using high dosage of fertilizer got introduced after 1966-67. Besides, its growth in the later period was also found almost limited to irrigated areas (Desai, 1986). As noted above (point 2 above), only 30 per cent of gross cultivated area had access to irrigation facility during 1982-83. Thus, with this limited irrigation facility the growth of HWs has remained adversely influenced, which in turn has adversely influenced the growth in fertilizer use.

4. According to the opinion of Joél S.S. (1985), in most of the agro-climatically homogeneous regions, villages, which have asphalted approach roads, have always experienced higher growth and development, compared to those which do not have any such approach road. Against this, a number of villages throughout India do not possess a transport linkage. For example, in the state of Gujarat 13.88 per cent of the total villages are inaccessible by modern transport. This makes it financially as also administratively difficult to provide the required amenities. Thus, the villages without transport linkage remained outside the main stream of fertilizer development. Therefore, the development of transport linkages will make a way for further increase in fertilizer use.
Here, on the basis of the above analysis it can be concluded that limited availability of irrigation facility followed by low spread of HWs, lower level of fertilizer production and inadequate facility of transport linkages constrained the growth of fertilizer use in the country. However, fertilizer development policy has met with the following achievements:

1. Agricultural sector in India experienced a substantial rise in the level of fertilizer consumption consequent upon a change in fertilizer development strategy in the successive five year plans (vide table: 3.2).

2. Fertilizer development policy seems to have ensured adequate and timely availability of fertilizers in the various parts of the country. Number of present studies show that farmers hardly report inadequacy and non-availability of fertilizers as the constraint in fertilizer use in certain areas.

3. Efforts with regard to the scientific use of fertilizers could be considered successful on the following grounds which were also envisaged in the fertilizer development policy:

   (i) A substantial increase in the use of phosphorous and potash compared to nitrogen has been obtained (vide tables: 3.2 to 3.4).

   (ii) A number of soil testing laboratories has increased in India over time. The number of soil testing
laboratories working at the end of 1950-51, 1960-61, 1971-72 and 1978-79 were 10, 42, 198 and 366 respectively (Babaria 1982).

(iii) The role of extension service has been emphasised considerably in the successive plans. In this context, the recent introduction of Training and visit system (T & V system) in the rural areas can be considered as an advanced stage with respect to extension services.

4. Due importance has been given to the spread and development of organic manures. Government has made special efforts in this direction (FAI: 1980 pp. 71-78). They are:

** The cowdung Gas Plant popularly known as gobar gas plant provides nutritious manure. In this connection, Government has encouraged the establishment of gobar gas plants in the successive plans.

** Large quantities of waste materials are available as vegetable refuse and as animal wastes in urban areas which can be converted into useful compost manures. The preparation of town compost on a large scale is being taken up by many municipal corporations and state Agro-Industries Corporations.

** Good efforts have been made to increase the usage of organic manures particularly of farm yard manures, green manuring, oil cakes, etc., among the farmers.
5. There is a substantial rise in the credit facility provided by various agricultural financing institutions, in the country. For example, Multipurpose Co-operative Primary Agricultural Credit Societies in India as a whole advanced loans of Rs. 33,79,394 thousand in the year 1965-66 which increased to Rs. 1,76,72,764 thousand in the year 1980-81 (FAI Annual 1985-86).

6. The amount of fertilizer subsidies rose quite significantly over time (Desai, 1986) which clearly indicates that the Government has played an active role in stimulating fertilizer use. Thus, fertilizer has occupied an important place in the Central Government budget.

7. With the introduction of a number of fertilizer plants, the country has succeeded in attaining a high level of fertilizer production at home which is evident from Table 1.3 given below:

**Table 1.3**

<table>
<thead>
<tr>
<th>Year</th>
<th>N (*1000 tonnes)</th>
<th>P (*1000 tonnes)</th>
<th>Total (*1000 tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951-52</td>
<td>28.9</td>
<td>9.8</td>
<td>201.6</td>
</tr>
<tr>
<td>1961-62</td>
<td>154.3</td>
<td>65.4</td>
<td>1,113.5</td>
</tr>
<tr>
<td>1971-72</td>
<td>749.2</td>
<td>290.3</td>
<td>3,741.2</td>
</tr>
<tr>
<td>1981-82</td>
<td>3,143.3</td>
<td>950.0</td>
<td>10,374.7</td>
</tr>
<tr>
<td>1985-86</td>
<td>4,322.9</td>
<td>1,430.2</td>
<td>14,438.0</td>
</tr>
</tbody>
</table>

\* Excludes N meant for non-agricultural purposes.
\* Excludes \( \text{P}_2\text{O}_5 \) through direct application of phosphate rock.

8. A number of important aspects required in fertilizer development policy ignored in the first plan got due recognition in the successive plans. These refer to intensification of soil testing, development of extension facility, attempts to raise fertilizer use in rainfed areas, attempts to use organic and biological wastes, etc. Thus, Government succeeded to obtain a number of positive aspects conducive to the fertilizer development in the course of time.

In view of various fertilizer development constraints, the above achievements deserve appreciations. However, these achievements have failed to bring in the optimum state with respect to fertilizer use in Indian agriculture. This was mainly due to a number of drawbacks consistent with the achievements which have been presented as follow:

**Drawbacks:**

1. Against the envisaged substantial rise in fertilizer consumption, a number of states experienced a significant fall in their respective average growth of fertilizer use during 1982-83-85-86 when compared with the average growth of fertilizer use in the years 1975-76-78-79 (vide table:3.4 to 3.12). Thus, a number of states have failed to raise their respective growth in fertilizer use over time.

2. Fertilizer consumption has of course increased significantly over a period of time. However, the incessant efforts of
the Government to popularise fertilizer use among farmers seem to have succeeded to a very limited extent. The studies over a period of time indicate that quite a good number of our farmers growing variety of crops in different parts of the country do not use fertilizers (Patel A.S. 1973 and Rangaswamy 1986). In this connection, it is possible to increase fertilizer use by popularising the modern agricultural technology among the farmers who are outside the main stream of technological development.

3. Despite the fact that the Government introduced a number of measures to improve the fertilizer distribution system over time, it has achieved much less in this respect even after 35 years of experience as is evidenced by some of the present studies. These studies indicate that a number of retail outlets have decreased against the envisaged target of increasing them in the Seventh Plan.

4. Of course, Government steps with respect to scientific use of fertilizers deserve appreciations. However, a number of recent studies indicate that farmers follow unscientific fertilising practices in terms of application of various nutrients either more or less than the recommended ones, in various parts of the country. Thus, the Government has failed in educating our farmers to use fertilizers optimally. In this context a study by Sinah Inder Pal et.al. (1987) guessed serious ecological problems in the years to come on the basis of a scientific experiment. Therefore, new fertilizer development policy should
provide an atmosphere to attain the scientific fertilizer use among the farmers.

5. In the Fourth Plan, it was recorded that the extension efforts by the Government were far from satisfactory. Then, in 1985, Joji S.S. in his presidential address to the 43rd Annual Conference of the Indian Society of Agricultural Economics pointed out that, "Extension Services in India have developed only as a delivery system in terms of the number of workers and the extent of the subject-matter specialists covered. Consequently, the farmers and rural communities have been subjected to a bombardment of new methods, practices and techniques, without generating absorptive capacity and the desired level of responsiveness among the respondent groups and the targeted individual" (Johl, 1985). Even at present a number of studies hinted at the significant inadequacy in this respect. Hence, the improvements in the present extension system are likely to raise the fertilizer use in India.

6. Soil testing laboratories precisely attempt to introduce balanced fertilizing practices in the agricultural sector. However, it has been found that till today soil testing laboratories face many problems in its functioning viz., lack of funds, difficulty in instrument repair, non-availability of chemicals, insufficient staff, post vacant, frequent transfer of staff, staff not properly trained, lack of proper infrastructure for sample collection, out
dated soil test based fertilizer recommendations, lack of availability of electricity etc. (Dhar and Singh, 1988), which have hindered the development of balanced fertilizer use in Indian agriculture.

7. Since the first plan it was recognised that chemical fertilizers should be used as far as possible along with organic manures. However, the picture that emerged in this respect is found to be quite different.

8. Fertilizer development policy proposed various measures to encourage the use of bio-fertilizers during the different plan periods. Consequent upon these measures in 1976 there were about 40 private and Governmental agencies involved in the production of these fertilizers. However, later on the number of private agencies decreased drastically (Tauro 1981). The reasons for the observed state of affairs are needed to be investigated.

9. Since the first plan, subsidy and credit facilities have increased substantially in Indian agriculture. However, the recent trend in this respect poses a very serious problem. The subsidy-credit ratio during the first year of the sixth plan was 1:2 which declined to 1:87 in the last year of the plan (Agrawal 1986). Thus an effective demand for credit seems to have shown a decreasing trend indicating thereby a sluggishness of interest among the farmers towards investment of funds in agriculture. The situation is thus an alarming one for future agricultural development.
10. The Central Government designs the fertilizer development policy but except introducing some scattered research studies, it does not seem to keep an eye upon the region specific problems, prospects and performance of the various State Government. This drawback can be considered as most responsible for the uneven and unsatisfactory growth in fertilizer use in some of the states.

The important enquiries emerging from the fertilizer development policy can be put up as under:

(a) which measured should be introduced to improve the current distribution system? and how?
(b) how to increase the number of farmers using fertilizers?
(c) which measures should be taken for generating the effective demand for credit?
(d) what are the types of changes required in the present extension and soil testing services to promote scientific fertilizer use?

Besides, certain issues have emerged presently which need urgent attention. These issues refer to the negative impact of unscientific fertilizer use resulting in low yield, low return, waste of resources, degradation of ecological system and thereby overall decline in fertilizer consumption. Unless due attention is given to this, it will ruin the future ecological environment that will further discourage fertilizer use (Subba Rao D.V. et.al. 1987). Apart from these issues i
equally important to examine the impact of fertilizer development policy at the grass-root level i.e., upon the farmers and the attitudes and opinions of the farmers towards fertilizer development policy. Thus, it becomes evident from the above analysis that there exists a wide scope for raising fertilizer use through the introduction of a number of measures in the present fertilizer development strategy. In this connection, in the following presentation, it is attempted to present some important constituents to be emphasised with respect to the future fertilizer development strategy.

Towards the Future Fertilizer Use Development Strategy:

With the background of the above analysis, it can be said that non-economic factors have proved to be the major constraints in the growth of fertilizer consumption. In one of his articles Desai G.M., (1986 p. 928), also brings in light the same observations as: "Under the present price environment, there is a vast scope to accelerate growth in fertilizer consumption through non-price policies which improve efficiency of fertilizer use, shift response functions upwards, and remove deficiencies in agricultural research, extension and credit as well as fertilizer supply and distribution system." Hence, it is pertinent to examine in details the various constituents of the non-economic fertilizer development factors which is attempted below:
Balanced Fertilization:

Scientifically it is maintained that the application of N in relatively larger quantity than that of P and K, soil is likely to get depleted for the latter nutrients. Hence this would need larger use of P and K in the next stage of fertilizer use. In 1971-72 the use of fertilizer was in the ratio of 6N: 2P: 1K whereas the desired ratio for the country as a whole has been put as 4.2.1. (Shenoi 1975).

Technical Pre-requisites for Optimal Response:

Like other inputs fertilizer use also observes the law of diminishing returns. If all the inputs are used in optimal combination, the yield response to fertilizer increases with its increased application level afterwards, after attaining the optimum position it tends to decline. The particular fertilizer dose offering optimum yield level of course vary from field to field and from crop to crop depending on the fertility of soil. This optimum level of fertilizer application alone maximises profit. Basically, four broad technical preconditions have to be satisfied for obtaining the best response from fertilizer use given below:

I. The fertilizer use should meet the nutrients deficiency of the soil.

II. It should meet the nutrient requirements of the crop.

III. The type of fertilizer used also should be appropriate to the soil and the crop.

IV. There should be an optimum combination of other improved inputs and cultural practices.
Briefly these preconditions have been explained below:

The first two preconditions mean that the fertilizer dose should be both optimum and balanced, considering the nature of the soil and crop. The first step in this direction is to test the soil. This test reveals the degree of alkalinity or acidity of the soil. Different crops have different acidity requirements. Once suitable acidity reaction is secured in the soil, the second soil characteristic to be examined is the status of the soil regarding available N, P₂O₅ and K₂O. The soil testing laboratory has also to consider the yield targets generally aimed at by a farmer for each crop before recommending the doses of fertilizers.

Thirdly, the soil test should also reveal the deficiency of micro nutrients. It is the experience that high fertilizer doses remove from the soil minor elements like boron, copper, zinc, etc. Failure to compensate the soil with these nutrients is also one of the responsible factors for existing low productivity in Indian agriculture.

The fourth characteristic that has to be studied about the soil relates to the physical nature of the soil which differentiates the soils' capacity to hold moistures and fertilizer and of feeding the plants. The physical and chemical properties of the soil are significantly related with the doses of N, P₂O₅ and K₂O and the timings of fertilizer application.
III. The fertilizers to be applied possess different qualities with regard to solubility in water and movement into the soil solution. Again, soils are also of different nature varying from sandy to clayey. The nature of the soil governs the movement of applied fertilizers. Thus, fertilizer application will vary in relation to: (a) the nature of fertilizer, (b) the soil type, and (c) the difference in nutrient requirement and nature of field crops.

IV. Optimum combination of other inputs and package of practices: The Fourth Technical Pre-requisite:

The requisite is extremely important. Optimum tillage of land, good water management, use of viable healthy seeds and seedlings with proper spacing, optimum plant protection measures, timely weeding, etc., alone can help the plant to convert fertilizers into optimum produce with the greatest efficacy. Such input management is known to double the response to nitrogen from 1.10 to even 1.20 or more (Sekhon and Kahlon, 1976).

Farmers' Attitude towards fertilizer Use:

In the past, it was found that farmers had some irrational beliefs regarding fertilizer use. They are:

(i) the use of fertilizer burns the soil,
(ii) organic manure is far better than chemical fertilizer,
(iii) N nutrient is superior to $P_2O_5$ and $K_2O$ consequently the only use of N unaccompanied by phosphates and potash, etc. (Shenoi, 1975). In view of such beliefs, it would be useful to conduct opinion surveys of the farmers from time to time in order to improve their understanding and attitudes towards the new scientific fertilizer use. This is attempted in the fourth chapter of this study.

Management of Technical Services to promote Fertilizer Use:

(1) Training and Education:

Field demonstrations occupy a central place in the training and education of farmers for the profitable use of fertilizers. Field demonstrations convince the farmers that fertilizer use yields handsome profit per hectare per unit of time. However, exclusive attention to fertilizer use alone would fail to present the striking difference that fertilizers can make to the economy. Hence, along with fertilizer demonstrations all inputs' demonstrations need to be arranged at a point of time. The results of the demonstrations should also reach the farmers.

(ii) Soil Testing:

The extension personnel and farmers have to be trained how to scientifically take samples of the soil for testing. Then, a regular programme has to be made out for the appropriate
communication between the farmers and the laboratories. A soil sample has to be taken after the harvest and tests' results should be sent well in advance of the next crop season. Of course, this requires very precise planning. In this connection, evaluation of soil testing would constitute of (i) accuracy of soil test, (ii) promptness in service by soil testing laboratories, (iii) the farmers' awareness about the rationale and benefits of soil testing, (iv) acceptability of soil test results to the farmers and their response in terms of following the soil test recommendations etc. All these constituents are examined in the fourth chapter of this study.

(iii) Fertilizer Quality Control:

This service ensures the supply of pure and unadulterated fertilizers. The efficient inspectorate staff is required for taking random samples of fertilizers from shops at various periods and particularly on the eve of the manuring season. This staff should take on an average one sample for every 250 tonnes of fertilizer material expected to be sold in the area every year and be forwarded to the fertilizer control laboratories for analysis. Then, the results of fertilizer quality tests should be published annually and different action for adulterated fertilizers should be taken against concerned dealers so that farmers feel more confident about the purity of available nutrients.
Apart from above aspects, other important aspects for fertilizer development strategy involve: efficiency in fertilizer production and import operations, management of fertilizer distribution system, organisation and co-ordination for fertilizer development services, etc. But these aspects are excluded in the present study for not being within its purview. However, a complete fertilizer development policy will have to incorporate all of them to attain the optimum level of fertilizer use in India.

To sum up, one of the principal objectives of Indian agricultural policy is to raise our agricultural production through rapid increase in fertilizer use. Of course, in the past fertilizer use has impressively increased over time. However, it has yet to attain a significantly higher level to feed the teeming millions of populations in the country in the years to come. Besides, fertilizing practices need improvement. The depletion in the quality of soil as a result of unscientific fertilizing practices, as it is taking place at present has to be checked. In fact it has led to the imbalanced eco-system which is the most alarming issue for the present as well as the future of India. In this view, Indian agricultural policy should aim at taking strong measures which encourage farmers to adopt and develop scientific practices in fertilizer use at farm level. Only then the envisaged high level of agricultural production will be attained while the negative side effects are minimised in the years to come. In this context the concerned area of future research may be stated as: how to raise fertilizer use in the most scientific way? This study is a humble attempt to answer this question.
Notes:

1. In this context mention may be made for the studies of:
   (ii) Growth of Fertiliser Use in Indian Agriculture by
   (iii) Agricultural Development in India - A new strategy
        in Management by Shenoi P. V. (1975).

2. In the Seventh Five Year Plan the Government of Gujarat
   expects to generate 68 per cent of the total additional
   production of foodgrains with the help of additional ferti­
   liser use (Vide appendix : 1). Thus, fertiliser use is the
   most important current input for agricultural production.

3. Here it may be noted that some parts of the soil are very
   rich with respect to P₂O₅ and K₂O also (Shah et.al. 1985).

4. Throughout the plan periods this issue has remained the same
   and hence it has not been repeated in the following plans
   while presenting observations.


   Subba Rao et.al. (1984), Rao Subba et.al. (1985).

   (1986), Patel and Charan (1986), Subramaniyam (1986), Supe
   et.al. (1986).
8. Desai Vasant (1984) noted that in the later part of the
Sixth Plan one of the main reasons for the lower yield
in the Indian agriculture was less intensive use of manures
in the 60's and 70's over the past.

9. This was also found while discussing with the various
Government Officers by the researcher.