CHAPTER II

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Comprehensive review of literature is an essential part of any scientific investigation. The main functions of review of literature are

Determining the work done before and thus assisting in delineation of problem area.

Provide a basis for development of theoretical framework.

Provide an insight into the method and procedure.

Suggest operational definition of major concepts and

Provide a basis for interpretation of findings.

In this chapter efforts have been made to collect relevant literature relating to the fertilizer distribution, consumption pattern and economic response of fertilizer in wheat and bajra in district Sawai-Madhopur, Rajasthan. However, the research problem is quite new and totally field oriented. Very few studies have been conducted in India on this problem. A brief review of the work relating to the problem as such in systematic way as possible undertaken is given below in various heads.

1. Socio-Economic Variables.

(i) Socio-economic status and economic motivation

(ii) Education and knowledge level

(iii) Age

(iv) Caste distribution

(v) Risk orientation

(vi) Participation in social organization
2. Infrastructure of various agencies engaged in distribution of fertilizer

3. Consumption pattern of fertilizer
   i. Consumption of fertilizer
   ii. Information regarding the use of fertilizer
   iii. Fertilizer consumption and cropping pattern
   iv. Size of holdings and consumption of fertilizer
   v. Method of application of fertilizer and cropping pattern
   vi. Constraints in fertilizer use and suggestions for promoting fertilizers distribution and consumption


5. Economic response and productivity of fertilizer

(i) Socio-Economic status and economic motivation

Socio-economic status farmers was found to be significantly associated with the adoption of agricultural innovations in general and fertilizer use in particular (Despande, 1962; Reddy, 1962; Bose, 1965; Kotle, 1967 and Rao, 1968). A positive association of Socio-economic status with use of fertilizer was also reported by Noule (1965), Nair (1969), Singh (1969) and Choudry (1970).

Chauhan (1970), stated that most of the adopters come under higher income status group and non-adopters in lower economic group. Chaudhry (1972), reported that socio-economic status was associated with adoption of fertilizer. Singh (1977) found that the highest (57.0%) of the total respondent belonged to lower middle socio economic status. A high degree of correlation was established between socio-economic status and adoption behaviour of the farmers. Sharma (1978), stated that maximum respondents fall under the middle class socio-economic status followed by upper and lower class socio-economic status. Takhera (1985), found that socio-economic status was significantly associated with the level of fertilizer consumption. Meena
(1989), reported that socio-economic status was found significantly associated with extent of fertilizer utilization. Singh and Roy (1983), showed in their study that economic motivation contributed positively and significantly to the level of fertilizer use of the small and pooled sample of farmers. Gupta and Vyas (1990), concluded that non-tribal women denoted to have relatively higher level of aspirations in all areas which were studied than their counterparts from the tribal areas. The socio-economic status has been successful in developing new aspiration among the farm women of both the groups.

(ii) Education and Knowledge Level

Junghare (1962), found positive correlation between education of the farmers and adoption of improved farm practices including fertilizers. Yadav (1964), reported that there is continuous increase in the high yielding varieties, fertilizer and improved agricultural implements as the education level of the farmers increases. The reason is quite obvious that literate farmers are more exposed to mass communication methods as well as to the change agency. The literate farmers understood easily the complicated technology. His findings were in conformity with that of Tripathi (1960), Awasti (1968) and Gupta (1968) who derived similar conclusion in their studies. Misra (1975), found that the maximum of 96% of big farmers were literate followed by 33.44 and 33.45 per cent small and marginal farmers respectively. Dattari (1980), reported that 69.3 per cent of non-contact farmers had high knowledge level regarding package of practices of paddy. Rathore (1987), found that 50 per cent of the adopted farmers had knowledge scores ranging from 51 to 75 per cent followed by 24 per cent who scored between 76 to 100 per cent. The remaining 15 per cent scored 26-50 per cent. Among the non-adopters farmers, 64 per cent farmers had knowledge scored ranging from 26-50 per cent, followed by 35% who scored 0-25%. The remaining 2 per cent scored 51-75 per cent knowledge. Krishnaveer (1988), reported that 40 per cent of wheat cultivators had knowledge scores ranging from 0-25 per cent followed by 19 per cent who scored between 26 to 50 per cent. Only 8 per cent of
wheat cultivars secured 51 to 75 per cent, remaining 12 per cent scored 76 to 100 per cent marks.

Nainawat (1980), found that in general, majority of the farmers had knowledge about the recommended production technology. Chaudhary (1991), found that 53 per cent of the farmers had medium knowledge score ranging from 35 to 60 per cent followed by high knowledge with 25 per cent who scored between 61 to 100 per cent and only 22 per cent of the farmers secured up to 34 per cent knowledge level respectively.

(iii) Age

Singh (1977), stated that maximum (45.50%) belonged to age group of 21-40 years followed by 35.50 per cent in 41-60 years of age and 18.50 per cent were above 60 years of age. Farmers below 20 years of age constituted only 0.5 per cent of the sample. The respondents below 20 years and above 60 years of age did not make decisions in adoption of innovations. Sharma (1978), reported that maximum 125 respondent belonged to age group of 25-45 years, 45 respondents having above 45 years of age and minimum 31 respondents belonged to age group up to 25 years respectively.

(iv) Caste Distribution

Singh (1977), found that (87.50%) of the respondents belonged to higher and medium castes, remaining 12.5 per cent to lower caste group. The correlation between caste of the farmer and adoption behaviour found was found non significant. While Sharma (1978), reported that maximum 102 respondent belonged to lower caste group followed by middle and higher caste having 57 and 91 respondents respectively, out of 200 respondents.

(v) Risk Orientation

Singh (1977), revealed that not a single respondent was found to have low level of risk bearing capacity. About 56.5 and 43.5 per cent farmers have shown high and medium level of risk bearing capacity. The association between risk bearing capacity and adoption behaviour of the respondents was
found significantly correlated and showed that there is direct correlation between these two variables.

Sharma (1978), reported that highest percentage of respondents have medium risk bearing capacity followed by low and high risk bearing capacity meaning thereby that the respondents were able to tolerate high risk in agriculture business. Singh & Singh (1970), reported that economic motivation and risk orientation were significantly contributing to explaining the variation in the adoption behaviour of farmers.

(vi) Participation in social organization

Bose (1961), reported that improved practices recommended by extension workers are not uniformly adopted by the farmers. An investigation was carried out in 10 villages to a certain the characteristics of the farmers who adopted improved practices including the use of fertilizers. It was found that those who have higher participation in community activities, showed the positive effect on the adoption of improved practices. Junghave (1962), found positive correlation between social participation and adoption of improved practices. Robin Chand & Gupta (1966), stated that positive and significant values of correlation of coefficient was obtained between social participation and adopters of farm improved practices indicating thereby that innovations and adopters of farm improved practices have more social participation. It has been further observed that the type of fertilizers required by the farmer at right time is not available at the retail sale point. Once the farmer comes at the retail sale point and does not get the fertilizer, he avoids to come at second time for the purpose in question. Singh (1977), reported that highest (42.0%) of the sample farmers belonged to the lower middle social participation followed by lower-middle, upper-middle and social participation of the sample farmers and their adoption behaviour was found to be non-significant.
2. Infrastructure of various agencies engaged in the distribution of fertilizer

Misra and Ram (1966), observed that largest sold item was fertilizer which was purchased from service cooperatives. The study further showed the reasons for non purchase of fertilizer and revealed that about 22 per cent respondents did not utilize them due to lack of irrigation facilities, about 16 per cent had misgivings about their utility, 12 per cent could not get the fertilizer of their choice nearly 10 per cent did not take either due to untimely supply or high cost. Singh et al (1970), stated that cooperatives had been the most effective agency for supplying credit and other inputs confined to seed and fertilizer. Shanker (1974), reported that the utility of economic value of any product has not only in its money value but also having it in the right quality, quantity, at the right place, at right time and at the minimum cost. From the time and place, the fertilizers is produced, it should be transported at the time and place of its consumption. Seasonality, of consumption and localized production of fertilizer has made the transportation as an important activity in distribution function of fertilizer. To make sure that the farmers get fertilizer in time and in the required quantity, it is essential to plan fertilizer movement. Misra (1975) concluded that due to poor financial condition, small and marginal farmers approach the cooperatives whereas middle and big farmers approach other distribution agencies. He further reported that higher than controlled prices and adulteration had been seen almost exclusively in the case of private and unauthorized market dealers. In the case of cooperatives, delay and high supply cost, difficult procedure and high rate of interest had been reported, whereas forced supply and several visits to the store for one transaction was reported in the case of Department of Agriculture.

Lal (1976), reviewed the places of different institution in fertilizer distribution in U.P. He stated that private agencies were the main agencies of fertilizer distribution. They accounted for 39.5 per cent of the total distribution in the year 1975-76. The cooperatives occupies second place in fertilizer distribution and accounted for 26.9 per cent of the total fertilizer
distribution. The percentage distribution of fertilizer by the Department of Agriculture was 16.3 per cent and that of the same department and Agro-Industries were 10.2 and 7.1 per cent respectively. Mittal (1976), revealed that cooperatives play a vital role in the distribution of fertilizer. During the year 1975-76, the cooperatives sold fertilizers worth Rs. 8000 millions which was worked out to be 60 per cent. However, the number of cooperative sale points was about 3900 accounting for 40 per cent of total sale points 9900 during the year. Cooperatives are adequately equipped with storage facilities. The cooperatives should be encouraged to purchase the fertilizer quite ahead of the sowing season. Cooperatives distribute bulk of the fertilizers against short-term production credit.

Sikder (1976), observed that most of the retail points are located at the railway stations or in urban areas. A large area of the interior part of the villages is not covered by adequate number of retail points, hence farmers had to travel a long distance for getting the fertilizers. It has been further observed that the type of fertilizers required by the farmer at right time is not available at the retail sale point. Once the farmer comes at the retail sale point and does not get the fertilizer he avoids to come at second time for the purpose in question which resulted non application of fertilizer in the field. In other words, the consumption of fertilizer is very much affected in the absence of adequate number of retail sale point of fertilizer nearer to its consumption. He further stated that cooperatives play a leading role in the distribution of fertilizers. More than 70 per cent of the country’s requirement was distributed through the cooperatives. The cooperatives have enough storage and godowns of fertilizers at mandi and village level. He further reported that total storage space utilized for storage of fertilizers at mandi and village both was only 2.27 million tones which fulfilled the requirement of fertilizers for only three months.
2. Consumption of pattern of fertilizer

(i) Consumption of fertilizer

Most of evaluation studies such as Agro-Economic Research Centre, University of Madras (1967) and Agro Economic Research Centre, Vishva Bharti (1967) in their respective studies of crop like wheat and rice have reported that there was considerable deviation in dose of fertilizer applied and the doses actually recommended.

Chaudhary and Prasad (1972), while giving comparative accounts of fertilizer use in progressive and non progressive villages have reported that out of 409 acres of cultivated area of the progressive villages, a major area the farmers received nitrogenous fertilizer in 375 acres of progressive villages, i.e., 80.00 per cent and 500 acres in non progressive villages, i.e., 57.16 per cent for 90.57 and 48.09 acres respectively as per recommendations. It indicates that the actual use of fertilizer was far below the recommended doses in both types of villages.

Jha and Shaktawat (1972), found that the level of adoption of hybrid bajra seed among farmers was 100 per cent, nitrogenous fertilizers 95.23 per cent, phosphatic fertilizers 92.85 per cent, potassic fertilizers 73.80 per cent. Desai (1973), observed that 80 per cent of cultivators used fertilizer only to one crop in the year and none applied fertilizer in more than three crops. Mahboob and Jiaul Karim (1974), while analyzing adoption of fertilizer in Bangladesh reported that 50% of growers applied potash. It was also found that almost half (46 per cent) of growers did not use any fertilizer. The findings indicated that fertilizer used was for below the demand level.

The Economic Times Research Bureau (1975), reported that annual growth rate of fertilizer consumption fell down from 20.4 per cent in 1971-72 to 12.9 per cent in 1972-73. It further fell down to 5.2 per cent in 1973-74 and to 3.8 per cent in 1974-75.
Bhilegaonker (1976), observed in his research findings that in 1972-73, the farmers consumed 12.24 Kg N, 5.33 kg P$_2$O$_5$ and 4.26 kg K$_2$O per acre whereas consumption of these nutrients in 1974-75 were observed to be 10.54 Kg. N, 3.67 kg P$_2$O$_5$ and 3.48 kg. K$_2$O per acre.

Das (1976), stated that the consumption of fertilizers in Punjab was 47.3 kg., Tamil Nadu 33.5, Kerala 22.8 kg, U.P. 17.8 kg and Orissa 7.1 kg per hectare.

Dwarka Nath (1976), reported that the fertilizer consumption remained more or less static at a level of 23000 tonnes of N$_2$, 8020 tonnes of P$_2$O$_5$ and 7200 tonnes of K$_2$O. He further reported that the consumption of chemical fertilizer increased significantly during past three decades. The uptake of nitrogenous fertilizers which was 31450 tonnes during 1966-67 jumped upto 131389 tonnes of N$_2$ during 1975-76. Similarly, consumption of phosphatic fertilizer increased from 9808 to 38118 tonnes and that of potassic fertilizer reached a level of 34313 tonnes from 12240 tonnes during the same period.

Economic Times Research Bureau (1976), reported that world consumption of all fertilizer fell by 2.5 per cent, Nitrogen accounted largest world fertilizer consumption followed by phosphatic and potash.

Saxena (1976), reported that the level of fertilizer consumption in India (16 kg/ha) of areable land is negligible as compared to consumption level of Japan, U.K., Belgium, New Zealand, Egypt, Israel and Canada being 387 kg, 256 kg, 509 kg, 602 kg, 155 kg, 151 kg and 24 kg per hectare respectively. The highest consumption per hectare was noted as 717 kg in Netherlands. Inspite of such a low level of fertilizer consumption per hectare in our country, the demand of fertilizer for exceeds its production and a large portion of demand is met out from its import.

Soma Sundaram (1976), in his diagnostic study of farmers in respect with new agricultural technology and of effective communication for adoption reported that out of three main fertilizer (NPK), nitrogen was applied by
majority of small farmers followed by phosphatic fertilizers, least applied was potassic fertilizers.

Sundaram (1976), stated that despite of promotional measures under taken both by the Government and Fertilizer industry, the recent consumption trend presented a rather distinguishing nature, while the overall consumption doubled nearly every five year till 1971-72. He further revealed that the consumption of NPK in six states, viz. Andhra Pradesh, Tamil Nadu, Gujarat, Maharashtra, U.P. and Punjab together accounted for over 65 per cent of the total consumption of fertilizer of the country. The Agricultural Ministry remarked that about 45 per cent of total fertilizer consumption is confined to only 55 district of the country.

Tripathi (1976) reported that U. P. in the North zone, Maharashtra in the West zone, Andhra Pradesh and Tamil Nadu in the Southern zone and Bihar in the East zone were the bulk consumers of fertilizers in general and N, P₂O₅ in particular.

Ghidyal and Sachan (1977), stated that fertilizer consumption in India has increased from 0.4 million tones in 1961-62 to nearly 2.8 million tones in 1975-76. He further remarked that in spite of concerted effort to increase indigenous production of fertilizers to meet the growing demand, there is a big gap between the requirement and production of fertilizer. This gap according to reliable estimate is likely to continue for a longer period to come. At present about 35 per cent of our total requirement is met with import.

Sodhi (1977), stated that the average consumption of fertilizer in India is at level of 20.60 kg. per hectare as compared to 84.6 kg/ha in the U.S.A., 328.10 kg in Japan and 154.9 kg/ha in Egypt. The interstate variation is as much as 1.1 kg/ha in Assam and 61.6 kg/ha in Punjab.

John Ahannon, Chairman IFDC, USA (1978), said that developing countries accounted for 77 per cent of the fertilizer consumption and 87 per cent of fertilizer production in 1978. Within developing World, Asia
including China produced and consumed roughly 70 per cent of total consumption and production of fertilizer of the developing World.

Mutiah (1978), stated that in case of adoption of correct recommended dose of fertilizer, 56 per cent of the participants adopted fully, 30 per cent adopted partially and 14 per cent did not adopt at all.

Sethy (1978), in his study conducted in Cuttack district of Orissa reported that 11.25 per cent of farmers in case of P₂O₅ and 7.5 per cent farmers in case of Potash application had fully adopted the recommendations. The rest of the farmers were found to be partial adopters.

Tyagi (1978), stated that out of total estimated consumption of fertilizers, wheat accounted the highest share followed by rice whereas the cash crops like sugar cane and potato accounting only 7 per cent of total cropped area accounted for 23 per cent in the State.

Bhilegoanker (1979), reported that the average fertilizer consumption in terms of total nutrients (NPK) in Parbhani district, Maharashtra were 19.03, 22.89 and 23.92 kg per acre respectively for big, medium and small farmers which was far below the recommended levels even the base year 1972-73 (before constraint). The consumption during 1974-75 came down to 16.50, 18.00 and 20.00 kg. per acre for the same category of farmers respectively. Similar trend was observed in respect of nitrogen, phosphorus and potash for all three categories for all three categories of farmers.

Dongal (1979), inferred that 90 per cent of the farmers had adopted improved seed followed by adoption of nitrogenous fertilizers. The minimum adoption was about the use of potassic fertilizers.

Singh and Mathur (1982), reported that there was existed a maximum gap of 11.52 per cent in case of marginal farmers followed by medium and small farmers being 22.72 and 35.76 per cent respectively in use of fertilizers in bajra farming. Contrary to this technology gap in phosphate and potassic fertilizers were very high (81.52 and 81.88 per cent). The most important
phenomenon observed was that gap in case of fertilizer in all three categories differed significantly from each other.

Randhawa (1958), round that nitrogen fertilizer was applied to the rice crop by all the farmers in all three agro climatic regions of Punjab. The highest average dose of 56.6 kg N/ha was used by the farmers of arid region against the recommended dose of 50 kg N/ha. The overall average dose used by Punjab farmers in all three regions came to 52.9 kg/ha which was about 3 kg higher than that of recommended level.

Phosphatic fertilizers were not used by all farmers in all three regions. In central region, maximum number of farmers (82.7 per cent) applied 75.5 kg/ha against recommended dose of 72 kg/ha. Only 18.7 per cent farmers used phosphatic fertilizer with an average dose of 14.2 kg/ha. Potassic fertilizer was used by 8.4 per cent farmers in all three regions with an average dose of 10.6 kg/ha. Majority of the farmers (52.6 per cent) applied more than the recommended dose. About three fourth of the farmers (78.44 per cent) used 25-50 per cent of the recommended level of Zn, 18.2 per cent applied 50.75 per cent, while remaining 3.4 % farmers applied 75-100 per cent of the recommended dose of Zn.

Meena (1989) reported that average fertilizer utilization by the farmers in a year was 32-35 kg/ha (N+P₂O₅+K₂O). The nitrogen utilization was 22.93 kg/ha phosphate was 6.72 kg/ha phosphate was 6.72 kg/ha and potash was 2.69 kg/ha.

Fertilizer utilization for small farmers in a year was 26.43 kg/ha (N 19.49 kg+ 5.58 kg. P₂O₅ + 1.37 kg K₂O/ha). In case of medium farmers in a year, it was 34.59 kg/ha (N24.10 + 7.08 P₂O₅+ 3.41 kg K₂O/ha). The fertilizer utilization for large farmers in a year was 49.84 kg/ha (N 33.63 + 10.40 kg P₂O₅+ 5.81 kg K₂O per hectare).

(ii) Consumption of fertilizer and cropping pattern
NCAER and FAI (1974), reported that the cropping intensity had a negative effect on fertilizer use on the crops of wheat and jowar only, whereas its effect on the use of fertilizer per hectare on other related crops was significant. Cropping pattern index had negative effect on fertilizer use per hectare on wheat and maize only, indicating thereby that other factors influencing the fertilizer use remaining the same an increase in the percentage of total area under wheat or maize to area under all crops cultivated would reduce the quantity of fertilizer used per hectare under wheat or maize.

Misra (1975), observed that the acreage of all major crops decreased in all categories of farms and increased acreage trend was reported in minor vegetable crops due to hike in fertilizer prices in 1974-75 over its previous year.

Tiwari et al (1975), found that per acre expenditure on fertilizer was the highest in case of potato as compared to other cash crops. Similarly, the use of fertilizer was also the highest in case of wheat and maize as compared to paddy. They also reported that the farmers with relatively large holdings and more area under irrigation practiced more intensive farming. They made relatively more investments per acre on fertilizer, although the latter was much below the recommended doses for various crops. Evidently the use of fertilizer and irrigation were positively correlated with the size of holdings.

Bhilegaonkar (1976), reported in his study at IARI, New Delhi that change in fertilizer use was observed to the tune of 2.16 kg. per acre in the case of big farmers, 4.89 kg. per acre of medium farmers and 3.76 kg per acre of small farmers. He further reported that the change in the cropping pattern during 1974-75 over previous year 1973-74 of different categories of farmers was found to have increased 28.4 and 30.4 per cent in Paddy and wheat, whereas 16.1 and 12.10 per cent area in cotton and groundnut went down by big farmers.
Pandey and Shah (1977), stated crops like paddy, sugarcane wheat and potato which are regarded essentially irrigated crops accounted for little over 55 per cent of the gross cropped area in the state. In 1972-73 only 70.89 per cent of total area under wheat was irrigated and 1/3 of wheat area was rainfed. This became a big constraint on the use of high yielding varieties of seed and consumption of fertilizers.

(iii) Consumption of fertilizer and categories of farmers

Lavania and Mishra (1972), reported that quantitative utilization of fertilizer per hectare for crops showed an increasing trend with a corresponding increasing trend with a corresponding increase in the size of farms except in the case of big farmers for wheat in which it declined by 9.14 kg from medium size group. In paddy, fertilizer utilization per hectare varied from Rs. 94.06 in small size group to Rs. 218.05 on big farms whereas in case of wheat it varied from Rs. 120.31 to Rs. 145.08 from small to medium size of farms. Proportion of fertilizer input to total input cost for paddy and wheat was observed to 12.95 and 5.74 per cent respectively. It varied from 12.27 per cent for big farmers to 14.13 per cent for small farmers in the case of paddy and from 5.49 per cent to 6.68 per cent from big to medium size of farms in the case of wheat. They further observed that the consumption of common fertilizer in HYV of paddy and wheat were ammonium sulphate, urea, DAP and mixtures.

Misra (1975), revealed that the consumption of fertilizer (nitrogenous fertilizer) by marginal, small and big farmers showed an increasing trend of 11.57, 32.60 and 41.0 per cent respectively. On the contrary per acre use of phosphatic and potassic fertilizers was very meager specially in the case of small and marginal farmers.

Tewari, et al (1975), found that 37 per cent of the sample farmers were incurring less than Rs. 30 per acre on the fertilizers whereas only four farmers constituting 3.4 per cent of the total farmers of the sample were spending more
than Rs. 100 per acre. Small farmers were spending more investment on fertilizer as compared to big farmers.

Lal (1976), observed that the consumption of chemical fertilizer was highest in the case of paddy and wheat crops. Total consumption of N, P, K, both from organic and fertilizers on an average was 94.5 kg. on paddy and 114 kg., 68.5 kg. and 68 kg. per hectare on wheat. The consumption of organic manure per hectare showed a decreasing trend with an increase in the size of holdings whereas reversed trend was observed for chemical fertilizer.

Ranganathan (1977), reported that in spite of 1.5 times more area in kharif season as compared to the area of rabi season, the consumption of fertilizer in the rabi was much more than that of the former one. It was also observed that the consumption of fertilizer in the same crop in the same village varied from farmer to farmer. Generally the small farmer applied much less fertilizer as compared to the big farmers.

Tyagi (1978), observed that the fertilizer used by the small farmers is much less as compared to medium and big farmers. In the case of wheat about 67% of total area under wheat of medium farmers and 74% area of the large cultivators received same chemical fertilizers whereas in the case of small wheat growers, the percentage was confined to 56 per cent.

(iv) Adoption level, quantity of fertilizer application and cropping pattern:

Desai and Narayan (1967), reported that the use of fertilizer in the case of hybrid maize was less than 50 per cent of the recommended dose for nitrogen and 25 per cent in the case of phosphatic fertilizer.

Gupta (1967), in his study of high yielding varieties programme in Aligarh district of U. P. that 50% of the cultivators growing hybrid maize applied less than half of the recommended dose while only 10 per cent of the cultivators applied full dose. Rest of the farmers did not apply any fertilizer at all.
Nair (1969), in his study reported that the farmers applied nitrogenous fertilizers only less than half of the recommended dose, 43 per cent farmers applied more than 50 per cent of the recommended doses. Only 6% of the of the total farmers participating in HYV programme applied full dose of recommended one of .Seventy one per cent of the farmers applied phosphatic fertilizers but majority of them applied less than 50% of the recommended doses. Only one per cent applied the full recommended dose.

Programme Evaluation Organization (1969), indicated in its report of HYV programme in kharif that 55% of the paddy plots received nitrogenous fertilizers at an average dose of 54 Kg. per hectare in the form of ammonium sulphate as against the recommended dose of 200 Kg per hectare. The application of P₂O₅ and K₂O was also far below than recommended doses. It was further reported out of 89 per cent participants only 12% used nitrogen, phosphorus and potash in combination . Nitrogen alone was used by only 15% and nitrogen in combination either with phosphorus or potash was used only by 27% of the participants.

Rao and Sharma (1969), in their respective studies at Saharanpur and Karnal district on the use of the of fertilizer for HYV program (I. R. 8) of paddy have reported that the application of nutrients to the crop was much below the recommended levels.

Singh (1969), in his study conducted at Delhi reported that the average dose of nitrogen, phosphorus and potash applied by the farmers participating in the HYV programme were 58.75Kg,21.75Kg. and 15.77 Kg. per hectare respectively as compared to recommended dose of 100 Kg.N₂,45.60 Kg. P₂O₅ and 30-40 Kg. per hectare of potash.

George and Choukidar (1972), stated that in kharif season, the farmers mostly used nitrogenous fertilizers. Potash and phosphatic fertilizers were not often used. The use of multi nutrients fertilizers was common for Rabi crops.
On an average, 43 Kg. N₂, 17 Kg. P₂O₅ and 19 Kg of K₂O were used for one hectare of I. R. 8 paddy.

Prasad and Chaudhary (1972), revealed that in case of adoption of nitrogenous fertilizers, the distribution of farmers in non-adopter, low medium and high adoption categories came to 7.50, 2.50, 65 and 25 per cent respectively in progressive village and 47.50, 5.00, 42.50 and 5.0 per cent respectively in non-progressive village. In the case of phosphatic fertilizer, the corresponding percentage were recorded as 57.50, 5.00, 35.00 and 0.5 for progressive village and 83.75, 3.75, 12.50 and zero for non progressive villages. As regards the use of potassic fertilizers is concerned, the study revealed a very poor response as in the case of non-progressive villages none of the farmers was using potassic fertilizer and even in the case of progressive villages only 7.50 per cent of the farmers were adopters and that too belonged to the medium adopter category.

Tandon (1972), reported that out of 28 farmers, only 23 used either no nitrogen or less than 50 per cent of the optimum dose. In the case of phosphorus, 22 farmers did not apply P₂O₅ and only one farmer used Potash.

Ziaul Karim and Mahbook (1975), reported that 50 per cent of the growers applied urea, about 1/6th of the growers adopted phosphatic and 5 per cent of them adopted potash. It was also found out that almost half of the growers did not adopt fertilizers. The findings indicated that the fertilizer use was far below the desired level.

Pandey and Shah (1977), observed that consumption of fertilizer in terms of NPK, per hectare of major fertilizer using crops viz., paddy, maize, cotton, sugarcane, potato and wheat was only 37.40 kg as against 46.00 kg and 79.50 kg in Haryana and Punjab respectively.

Ranganathan (1977), observed that even the big farmers applied the fertilizers in less quantity than that of recommended by agronomist.
Tyagi (1978) reported that among all food crops, wheat is the most beneficiary crop in respect with the application of fertilizer level whereas rice and maize received relatively very low share of plant nutrients. The rate of application of NPK in wheat per hectare was observed to be 97.6, 31.4 and 7.4 kg for all types of farmers as a whole. He further observed that per hectare application of plant nutrients was observed low in the case of small as compared to medium and large farmers. He further observed that 26.7, 3.2, 1.7 and 31.6 kg, per hectare NPK and total fertilizers applied by small farmers, 30.4, 5.2, 2.5 and 38 kg by medium and 27.4, 5.4, 2.7 and 35.5 kg by big farmers in wheat crop.

(v). *Constraints in fertilizers use and suggestion for promoting fertilizer distribution and consumption*

Mathur (1966), observed that 41.26 per cent farmers were not using fertilizer due to small size of holdings, 30.16 per cent due to non availability of fertilizers in time 29.18 per cent due to lack of financial resources and 22.07 per cent due to ignorance about advantage of fertilizers.

Singh (1966), stated that highest being 30.5 per cent respondents were not adopting fertilizers due to financial difficulties followed by 30 per cent due to lack of irrigation facilities, 15.0 per cent due to non availability of fertilizers at proper time, 8.0 per cent due to lack of knowledge and 5 per cent due to higher prices of fertilizers. Besides, fertile land, small holdings, lower yield and faith in fertility deterioration etc. were also observed the causes of non using fertilizers.

Agro-Economic Research Centre (1969), pointed out that almost all the farmers using fertilizers in time and in adequate quantity but hardly a few of them aware of dose of fertilizer to be used.

Singh and Singh (1972), reported that high cost of fertilizer and lack of irrigation facilities are the most important causes of use of fertilizer in adequate quantity.
Nesedia (1972), accounting to official assessment, the main reasons for the low level of consumption of fertilizer in comparison with the targets set have been:

(i) Natural causes, such as cyclones and flood in some states
(ii) Constraints in availability of credit for fertilizer distribution
(iii) Gaps in extension and promotional efforts
(iv) Inadequate fertilizer distribution arrangement
(v) Unfavourable price ratio between inputs and produce

Jai and Tripathi (1973), reported that 81.25 per cent farmers adopted fertilizers whereas 18.75 did not adopt and 15.18 per cent revealed in the category of non-adopters after some time. The causes of non adoption of fertilizers were highlighted as inadequate and untimely supply and high cost of fertilizer, increasing crop susceptibility to pest, development of acidity and consequent deterioration of physical condition of soil

Fai + NCAER (1974), reported that the reasons for not using fertilizer in order of importance were inadequacy of fund and credit, inadequacy of irrigation water, lack of fertilizer availability in insufficient quantity and in time, risk and high cost of production due to use of fertilizer.

Sharma and Nair (1974), reported that high cost of fertilizer and untimely and inadequate supply were the main constraints for the partial adoption of fertilizers.

Sharma (1974), emphasized that for creating a significant impact on agricultural productivity through efficient distribution of fertilizers, there are four major areas in which appropriate policy decisions need to be taken as:

(i) Farmers awareness of the agronomic potential to be derived for the use of NPK at the recommended levels
(ii) Physical availability of fertilizer stock should be within easy reach of the farmers at the time of planting along with favourable price of fertilizer input relative to the additional income expected from crops.
(iii) Access to credit which permits the farmers to procure the fertilizer requirement immediately and

(iv) Distribution policy is motivated at macro-cum-micro level to promote the sale of fertilizer.

Somani and Lodha (1974), reported that high cost of fertilizer, lack of irrigation and credit facilities, lack of money with the farmers, low price of produce and lack of knowledge are the main problems and cause for judicious use of fertilizers. They further revealed that non-availability of fertilizer in the villages, fertilizer causing disease and pest, deterioration of taste of produce and adverse effect of fertilizers on the soil with the recommended dose of fertilizers.

Fertilizer Association of India (FAI) (1975), reported that apparent weather conditions, physical control, sharp hike in fertilizer prices, inadequate credit and untimely availability of fertilizers were some of the factors responsible for slowing down of the off take of fertilizers.

Bancel (1975), in his fertilizer innovation characteristics analyses, reported that transport, demand higher cost per acre and reliability of recommendation may contribute to low level of application. The establishment of economic and reliable recommendation play a major role in promoting the use of fertilizer. He further reported that adequate producer credit such as input based credit promote fertilizer adoption because they provide funds needed by small scale producers, relieve the risk innovation and at the same time allow the fertilizer application under condition of economically more competitive alternatives.

Bhilegaonkar (1976), reported that the most important problem faced by big, medium and small farmers was increase in the cost of production of crops because of high prices of fertilizers. Medium and small farmers perceived inadequate finance to watch the cost of production as second important
problem whereas big farmers perceived non-availability of right type of fertilizer in right time as the third main problem.

He gave concrete suggestion for promoting fertilizer consumption as reduction in fertilizer price, needs of financial facilities to be provided, timely availability of right type of fertilizer in the village or near by places, information regarding efficient use of fertilizer and increase in the price of produce have to be made. Besides, credit procedure should be simplified adulteration in fertilizers should be checked and provision of more facilities for soil testing have to be provided to the farmers.

Mittal (1976), stated that with a view of optimization of consumption of fertilizer, it should be stored at strategic location near by consuming centres. This system will save time required for supplying the fertilizer and will ultimately reduce the pressure of storage in the factories, godowns and silo’s and will also reduce the stress on transportation. Ready availability will ensure sales whenever and wherever required.

Ranganathan (1977), stated that among various reasons responsible for low doses of fertilizer application that that of recommended ones in U.P. were non-availability of fertilizer at proper time and place, inadequate supply of credit and inadequate irrigation facilities seemed to be most important. He suggested that in order to push up the consumption of fertilizer, the above mentioned problems have to be solved.

Setty (1978), reported that non-adoptions of recommended dose of fertilizer was attributed to lack of availability of desired fertilizer in time associated with high cost of fertilizer and lack of adequate credit facilities. Other reasons in order of their importance were non-availability of fertilizers in villages or within easy reach of distance, lack of knowledge regarding fertilizer application, increased susceptibility of crop to pests and diseases of crop to pests and diseases weed infestation and washing away of fertilizer by run off water.
Zechem-itz (1979), FAO, Bangkok, while discussing the problems on fertilizer use in developing countries, identified several problems such as inadequate information on the kinds and amount of fertilizer, inadequate research and extension services to provide farmers with information on the efficient use of fertilizer, lack of suitable crop varieties and irrigation services, unfavourable relationship between crop prices and cost of fertilizer (parity between crop and fertilizer price), in adequate of required fertilizer, inadequate marketing system for agricultural produce, lack of credit and defective system of land revenue of farm base arrangements which discourage the economic use of fertilizer.

Jha and Sain (1981), concluded from their study at Sholapur Akola and Mahbub Nagar (1975-78), that lack of irrigation and working capital at hand of the farmers were the main causes of non adoption of fertilizers.

Waghmare and Pandit (1982), reported that educational constraints were the main constraints in adoption of fertilizers followed by economic, socio culture are practical constraints in application of technology of chemical fertilizers.

Sharma (1983), reported that non availability of fertilizer in time, high cost and lack of knowledge about fertilizer were the main reasons for non adoption of chemical fertilizers perceived by the farmers.

Kunal (1984), reported that reasons of non adoption of recommended fertilizer doses as endorsed by the farmers were lack of knowledge about the merit of using fertilizers (4.88%), non availability (12.00 per cent), high prices (61.00) per cent diversion of fertilizer to irrigated plots (53.88 per cent) fear of heavy loss in case of crop failure (56.12 per cent) and unsuitability of dry land for inorganic fertilizers (4.88%).

Gervy (1985) reported that many difficulties are in countered in increasing fertilizer use. Logical problems, poor distribution arrangement, low fertilizer user efficiency, the uncertainties attached to obtaining on economic
return and the need to attend to other aspects of crops production such as improved varieties and use of irrigation.

Lakhera (1985), reported that unfavourable weather, step increase in fertilizer prices, unremunerative produce prices, inadequate credit and non availability of fertilizer at the time and place it is required were observed to be major reasons attributed for low consumption of fertilizers.

Singh and Ray (1989), found that high price of fertilizer was ranked as the most important problem by both small and medium farmers and the second important problem by the marginal farmers. Lack of finance, lack of easily available credit for fertilizer were perceived as very important problems by the marginal farmers as these were ranked as first and third rank respectively by them.

Ajore (1989), reported that lack of soil testing facility as a constraint in fertilizer use was perceived by all categories of farmers. Some constraints related with physical availability of fertilizer were also perceived by the farmers. For marginal farmers these were "non-availability of fertilizers in near by market", non availability of fertilizer in time, lack of desired type of fertilizer charges more price of fertilizer and adulteration of fertilizer. The same set of problems was also perceived by the small farmers with some variation in their degree of importance. Inadequate irrigation facility was perceived as a major constraint in fertilizer use by all the three categories of farmers. For marginal farmers these were "non-availability of fertilizer in near by market", non- availability of fertilizer in time, lack of desire type of fertilizer, charges more price fertilizer and adulteration of fertilizer. The same sets of problems were also perceived by the small farmers with some variations in their degree of importance. Inadequate irrigation facility was perceived as a major constraint in fertilizer use by all the three categories of farmers.
Meena (1989), reported that majority of the farmers expressed "unavailability of credit for purchase of fertilizer when it was required followed by high cost of fertilizer as the important constraints in use and purchase of fertilizer.

(vi). Sources of information regarding use of fertilizer

Bhilegaonkar (1976) revealed that source of information in judicious use of fertilizers was observed in rank order of I, II, III, IV, V for progressive farmers, friends, neighbours, family members and local leaders in personal locality, while in personal cosmopolite the agricultural assistant (college and block), village level workers, university scientist, Agricultural extension officers, Block development officers farmers of other villages and fertilizers agencies had I, II, III, IV, V, VI and VII level of ranking order respectively. Under mass media exposure, radio, film, written publications, kisan mela and news papers were observed in rank level of I, II, III, IV and V while other like demonstration, discussion, meetings and field visits had I, II and III rank order.

Ranganathan (1976), stated that in the United States, a random sample of 120 farmers in Iowa State was conducted which showed that 97 per cent of the farmers received reliable information regarding the fertilizer use from their fertilizer dealers, 79% expected the dealers to recommend them the method by which they should apply fertilizers, 60 per cent farmers expected to know from dealers about the amount type of fertilizer to be used.

Azad (1976), in his augural address on 2nd FAI Workshop on soil testing, expressed that the low level of fertilizer consumption indicated low benefit – cost ratio due to ignorance of farmers in judicious use of fertilizer to obtain profitable yields. He called upon the manufacturers of fertilizers, pesticides and seed producers to set up joint demonstration in the command area.
4. Fertilizer distribution of Govt. Quasi-Govt. and Private Agencies

Rangachari (1972), described the role of central fertilizer pool in fertilizer marketing as popularizing and increasing the use of fertilizers making them available to the cultivators at reasonable prices and ensuring equitable distribution of supply of fertilizers, import and distribution of specific fertilizer and act as a price lender. It has played a significant role in the development of fertilizer marketing in the country. In view of the gap between demand and indigenous availability of fertilizers, sizeable imports of fertilizers material was also made which in turn exert its influence in the field of fertilizer marketing.

Sankhyan et al (1973), reported that the distribution cost of fertilizer was observed to be higher in the case of private trade as compared to cooperatives for a similar brand of fertilizer. It was mainly due to higher margin, which they retained at the retailers level particularly at the time of short supply of fertilizer.

Johl (1974), opined that fertilizer price hike affected the production cost of wheat and rice adversely, which in turn became the basis of higher price of the products of the farmers, making a viscous inflation or circle. High price of fertilizer influences the small farmers to divert acreage from the crops requiring higher quantity of fertilizer like wheat and rice to those require less quantity such as gram, lentil, barley and pulses etc.

Mccone (1975), reported that the marketing cost of fertilizers including transportation, storage, packing, advertising and credit etc. accounted for a major share of the cost of fertilizer to the farmer. This is true specially in under developing countries where low volume and lack of marketing experience prevails, and hence, saving on marketing cost by adopting of efficient orderly marketing has a significant effect on the economics of using fertilizers.
Misra (1975), stated that the prices of all statutory fertilizer and pooled fertilizers are fixed by the Govt. of India, Ministry of Food and Agriculture. The prices of locally manufactured fertilizers are fixed by Fertilizer Association of India (FAI) in consultation with Govt. of India. He further observed that margin allowed for distribution of fertilizer by the Government is the same as for Department of Agriculture, Cooperatives and Agro Industries except in the case private distribution which was low for all types of fertilizers. He further, reported that Department of Agriculture, Private Agencies and adopted only cash sale system whereas in the case of cooperatives which adopt credit sale to their members. Cooperatives distributed 45.5 per cent of the total sale on credit basis whereas cash sale system was adopted as 31.7 per cent, 18.8 per cent and 4.40 per cent by Department of Agriculture, Private Agencies and Agro-Industries respectively.

Tiwari et al (1975), observed that per acre fertilizer use was increased with the increase in the amount of cooperative loan.

Annual review of fertilizer consumption and production (1976-77), revealed that the introduction of subsidy on phosphatic fertilizer by the Central Government with effect from 17th March 1976 of Rs. 1250 per ton played a substantial role in the reduction of cost of phosphatic fertilizer. Reduction of exercise duty on single super phosphate by the Government in December 1975 from 15 to 7.5 per cent provided a further stimulus to the consumption of phosphatic fertilizer.

Economic Times Research Bureau (1976), revealed that only 20 per cent of the farmers in the country were using the fertilizers due to its higher prices. In order to boost its consumption, the Government of India reduced the price of fertilizer twice within a period of 5 months during 1975-76. The price of area was reduced to Rs. 1750 per ton from Rs. 1850. Murate of potash was reduced from Rs. 1085 per ton to Rs. 900.00, whereas Ammonium Sulphate was packed at Rs. 935 per ton.
Kahim (1976), The Executive Director of World Food Council in his report of 1st session advocated that main elements of world fertilizer policy should include “Ensuring harmonies and balanced expansion in both supply and utilization of fertilizers in time with food production objectives.

2. Avoiding cyclical imbalance between supply and demand.

3. Ensuring that prices of fertilizers are established at reasonable levels.

4. Ensuring the developing countries to obtain fertilizer need for their food and agricultural production.

5. Promoting appropriate policies and programmes to stimulate fertilizer consumption in line with agriculture production of objectives.

Ranganathan (1976), remarked that the prices of fertilizers in the international market have displayed enormous fluctuation. He further reported that due to increase in fertilizer price with effect from June 1, 1974, there was a sharp decline in the benefit cost ratio of fertilizer application, which led to a steep decline in the fertilizer application particularly in the case of P and K. He further stated that the provision of packaged commodities (Regulation) Order 1975 promulgated by the Ministry of Industry and Civil Supplies be paralleled to fertilizer (control) order 1957.

The Indian Express Correspondents (1977), visualized that the chemical fertilizers play a vital role in maintaining the fertility of the soil, if the used in balanced doses. Proportion of NPK used in U.P. is quite different than that of recommended proportion as 4:2:1. To remove this imbalance, the State Govt. has sanctioned subsidy of 20 per cent to all farmers and 30 per cent to new land allottees on phosphatic and potassic fertilizers. The State Govt. has also decided to open more sale points of fertilizer in the remote and in accessible areas. The transportation charges of fertilizers through railways to their remote areas exceeding Rs. 10 per ton have to be borned by the Govt. of Uttar Pradesh.
Economic Response and Productivity of Fertilizers

Agarwal (1954-55), determined value of land, bullock labour and human labour for farm business and marginal physical products for irrigated wheat by fitting Cobb-Douglas type of production function to the farm management data for the year 1954-55 in U.P. He observed a low value productivity of human bullock labour and came to the conclusion that any further addition would lead to a decline in the return and productivity of their resource. He suggested that resources should be increased with the increase in the level of other associated inputs. A non-significant relationship was observed between bullock labour and yield of wheat as well as total farm returns and also between output and human labour for wheat.

Agarwal and Foreman (1959), measured resources productivity for farm business as a whole as well as planted sugarcane and wheat.

The observed that the profitability could be increased by increasing the levels of human and bullock labour in sugarcane and seed, manure-fertilizer and irrigation in wheat. Implements in 1955-56 although non-significant for farm business as a whole had marginal productivities of Rs. 2.46, 1.10 and Rs. 4.43 per rupee investment for wheat, sugarcane and farm business as a whole respectively.

Gill (1961), in his study conducted at Punjab found that proportion of wheat production increases with the increase of farm size.

Krishna (1964), fitted Cobb-Douglas type of production function to estimate marginal value productivity of inputs for Punjab farmers. He used 3 sets of equation by grouping some of the input variables in order to remove multicollinearity. He concluded that the marginal value products estimates of farm inputs are not so widely out of line with their acquisition costs.

Saran (1964), fitted Cobb-Douglas type of production function to the input-output data obtained from the studies in the economics of farm management. He fitted production functions for the farm business as a whole
as well for important crops like wheat, sugarcane and paddy, using the variables land in acre, human and bullock labour, manures, fertilizer and working expenses on irrigation etc. in rupees. He compared productivity of input particularly capital services between different regions and found that in all the three states namely U.P., Andhra Pradesh and Tamil Nadu and concluded that the use of fertilizer and manures and improved seed could increase farm income and production and production of important crops including wheat. The only exception was paddy in Tamil Nadu where lesser use of manures and fertilizer was needed for allocation of resources.

Naik (1965), studied the resource productivity by fitting Cobb-Douglas production function using the variables as water charges, agril. implements, hired labour, land, manures fertilizers and bullock labour. He worked out the marginal value productivity of only significant variables. The marginal value products showed that except land, manures, fertilizer, the other three classes of variables could not increase the output with its increased level.

Hopper (1965), used the production function of crops growth with traditional methods of production. He studied the operation of 43 farms in village Senapur, District Jaunpur in Eastern U.P. managed by the farmers themselves and fitted Cobb-Douglas function for each crop, namely barley, wheat, pea and gram. By examining the price implicit in the allocation of resources among various crops, he found that the use of the resources were efficient within the static economic meaning of the terms. The farmers, on an average, appeared to have successfully economized their scarce resources.

Singh (1966), conducted a study on the basis of data of the cost of cultivation of wheat on different size of holdings taken from a wider survey carried out in the Punjab in 1960-61. The sample of 155 holdings included 57 small, 65 medium and 33 large holdings. For each size, average cost per acre was calculated for human labour, bullock labour and net and gross prime costs as well as cost per maund of wheat. The correlation coefficients for size of holdings were observed to be (1) human labour (-0.23) (II) bullock labour (-
0.35) (III) cost per maund (-0.21) all of which were significant. The correlation between size of holding and output per acre came to 0.02 which was non significant.

Gangwar and Chhikage (1974), revealed that the cost of cultivation of wheat was the highest on medium size of farms and lowest on the smaller farms. The yield per hectare was found to be positively correlated with the size of holdings.

Singh and Patel (1974), made an attempt to examine the productivity of resources and allocation efficiency on different use of farms (120) adopting new technology in the Meerut district of U.P during 1969-70. Cobb-Douglas type of production functions was fitted for small, medium and large farms with factors of production as bullock labour, fertilizers, irrigation and human labour per hectare and the marginal value products were computed, comparisons were made between MVP and factor costs and between computed optimum levels and existing levels of use of different inputs and returns on different size groups of farm. Irrigation and fertilizers were found to be the most profitable resource for further investments.

Grewal and Rangi (1976), used time series data and related the production of paddy and wheat with fertilizer price and consumption of fertilizer. They concluded that the production of these crops was not dependent upon the input prices only but was governed by a variety of other factors.

6. General review on fertilizer contribution

Joti and Tripathi (1972), stated that out of total number of growers of maize, wheat and paddy, 86.0, 85.0 and 73.8 per cent of growers respectively utilized fertilizers. 60.0 % under groundnut, 63.0% in oilseeds and 52.0 % respondents under jute and mesta used fertilizers.

They also stated that although all the respondents (180) were aware of the use of fertilizers in different crops. Only 132 of them (73.3%) adopted
fertilizer practices. The number of respondents in the interest stage (163) gradually come down to 158 in the evaluation stage. A gradual fall in the movements of respondents from trial stage to adoption stage 80.5 to 73.3 per cent was observed in the adoption stage.

They further indicated that the majority of adopters (90.35 per cent) used fertilizers because of the increased yield. 72% of the adopters stated that the use of fertilizers increases income. The causes of non-adopters were stated as untimely supply of fertilizer accounted for 65.8 per cent of non-adopt, the second reason in order of importance was the inadequate supply of fertilizers accounting 60.8 per cent. More than half of the non-adopters (57.6%) replied that they preferred organic manures. Apart from these, 33.6 per cent said that fertilizers deteriorated soil conditions and 46.6 per cent indicated that they did not have the required knowledge for the use of fertilizers.

Tripathi and Singh (1975), observed that there was a maximum (66.5 %) of high adopters 30.0 per cent of medium adopters, 2.5 per cent low adopters, 1.0 per cent of very low adopters. As regards compost of CYM maximum 52.0 per cent was medium of high adopters, 36.5 per cent, 11.5 per cent low adopter and none was found to be non adopters. In the case of D.A.P. users among the farmers, maximum 61.56 per cent were low adopters, 26 per cent non adopters, 11.5 per cent medium adopters and there was only one per cent was the high adopter of D.A.P.

Paul (1976), stated that the contribution of various kinds of agricultural inputs in the improvement of agricultural output was found to be 43.0 per cent due to fertilizers, 27.0 per cent due to irrigation and other inputs contributed the rest of the per centage in the improvement of agricultural output.

Tandon (1992), reported that only reason why farmers use fertilizers is to increase the crop yield from their land. They know that only well fed plants can produce more. The objective is that after meeting the family needs, the surplus can be sold in the market to pay for cultivation costs and increase the
family income. Thus, the fertilizer helps to create and increase the marketable
surplus. He further visualized that how much increase in crop yield can be
expected by using fertilizer? The impact of fertilizer on crop productivity is
substantial. At least 40-50 per cent increase in agricultural production in
recent years can be credited to fertilizer alone though some estimates put this
figure as 75 per cent. No single factor can apply for all farmers because the
response of fertilizer depends on several factors like the soil fertility, amount
of fertilizer used, crop and its variety along with water availability and crop
husbandry in general. One of the factors behind the spectacular increase in
wheat and rice yields during the past quarter of the present century is the
fertilizer. Each Kg. of nutrient (NPK) added through fertilizer produces 8-10
kg of grain on an average depending upon farmer’s knowledge, skill and its
use in crop production. He further advocated that it is very common to have
double yield with fertilizer as compared to the crop grown without fertilizer.
He further remarked that the total quantity of NPK should be decided into
basal dose and top dressing. The basal dose generally includes total
requirement of P₂O₅ and K₂O and part of nitrogen dose.

Fai (1992), Fertilizer statistics published by Fertilizer Association of
India, 1992 gave statewise consumption of fertilizers. According to this, the
fertilizer consumption in term of N, P₂O₅, K₂O and total per hectare was
observed to be highest in Pondicherry being 284.4 kg N, 102.6 kg P₂O₅, 157.4
kg, K₂O and total 554.4 kg followed by Punjab being 125.2 kg, 44.1 kg., 2.0
kg and 171.2 kg, Delhi – 127.7, 30.4, 2.2 and 160.3 kg, Chandigarh 150.0,
12.5 and 165.0 kg, Andhra Pradesh 87.7, 34.9, 1.6 and 133.2 kg, Haryana
97.1, 30.3, 0.9 and 128.3 whereas minimum fertilizer per hectare was
observed in Arunachal Pradesh being 0.7 kg, N, 0.4 kg. P₂O₅, 0.1 kg K₂O and
1.2 kg total fertilizer. All India average consumption of N, P₂O₅, K₂O and
total nutrients was observed to be 46.4 kg, 18.3 kg, 7.7 kg and 72.4 kg per
hectare. As regards absolute quantity of fertilizer consumption in terms of
nitrogen, phosphatic and potassic fertilizer is concerned, U.P. stood first state
consuming highest nitrogenous phosphatic and potassic fertilizers being 1658
N, 447 P₂O₅, 95 K₂O and 2200 thousand tones as total of N+P₂O₅+K₂O, followed by Andhra Pradesh 1066, 424, 129 and 1619 thousand tones, Maharashtra-769, 390, 218 and 13377 thousand tones, Punjab-917, 323, 15 and 1255 thousand tones, Karnataka – 406, 244, 162 and 812 thousand tones, Madhya Pradesh as 478, 284, 42 and 804 thousand tones, Tamil Nadu as 390, 140, 244 and 774 thousand tones, West Bengal as 421, 200, 135 and 756 thousand tones, Gujarat as 409, 200, 64 and 673 thousand tones, Haryana as 455, 142, 4 and 601 thousand tones, Bihar as 431, 113, 43 and 587 thousand tones and Rajasthan as 251, 127, 7 and 385 thousand tones. The minimum total consumption of N, P₂O₅ and K₂O total nutrients was in Nagaland being 0.4, 0.3, 0.2 and 0.9 thousand tones respectively.

Das and Kalra (1994), reported that the effect of climatic variability on crop growth and yield is more pronounced in rainfed and semi rainfed areas as compared to irrigated agriculture. In India, about 70 per cent of the cultivated area is rainfed. They concluded that Indian agriculture is mostly influenced by the vagaries of the monsoons. Increasing demand for food security due to population explosion calls for a holistic approach to meet the weather induced uncertainties through development of suitable cropping system, efficient land and water management and judicious fertilizer application. The interaction of fertilizer, irrigation and climatic variability, particularly at low input usage need to be studied in detail to decide the optimum level of nutrient for maximum yield return. Based on analysis of climatic and soil data, a minimum quantity of nitrogen may be applied at sowing. Subsequent application may be based on the probability of rainfall distribution, occurrence of dry spells, soil water storage and feasibility of supplementary irrigation. A combination of suitable doses of N, P and K though of lower quantities should be applied to alleviate the effect of drought.

Sharma (1994), reported that under conditions of fertilizers scarcity and higher cost, economical use of fertilizers and their efficient management is of great significance. Extensive use of moderate to low doses of fertilizers with
an assured return in preferable to high inputs with comparatively lower and for risky monetary returns. The economic indicator commonly employed to measure profitability of fertilizer use is the benefit cost ratio (BCR), revealing there by the expected returns on the investment in fertilizer. It is generally accepted that a BCR of 2 in irrigated area and about 3-3.5 in rainfed crop is optimal to motivate the farmers to use fertilizers.

Modgal et al. (1995), reported that rice and wheat have been grown in system for ages in Ganga valley, though large increase in this double cropping system is a recent phenomenon. The so called green revolution was in true sense a revolution in the production of these two crops. Over the years rice cultivation has spread in north west and wheat cultivation in north east. In the 1950 rice and wheat accounted for only one third of the grain production in India, but by now almost 73 per cent of the national food grain requirement is being met by rice and wheat and this proportion is likely to rise to almost 77 per cent by the year 2010 A.D. The possibility of area expansion under these crops is not only remote, but it is likely that in the years to come crops diversification may limit area under cereals and the increase in production has to come from increased yield per unit area only as the annual growth rate of area in both rice and wheat in India decreased tremendously from 0.62 per cent during 1961-72 to 0.05 per cent during 1981-91 in the case of rice and from 4.36 per cent during 1951-61 to 0.44 per cent during 1981-91 of wheat. Rice-Wheat system, the major cereal producing system is expected to play an increasingly important role in producing food grains for the increasing population. To sustain the productivity of this cropping system, efficient nutrients management is vital. They further reported that adequate amount of nutrient use is the pre-requisite to enhance the yield and to sustain them. At present productivity as well as fertilizer use varies considerably in different regions and grossly inadequate amount of nutrients are added in large areas in this exhaustive system. Thus, the application of sufficient nutrients in balanced doses is needed.
Zutshi (1995), in his inaugural address in symposium on “Advances in Fertilizer Production Technology” organized by Fertilizer Association of India (FAI) New Delhi on April 6-7, 1995 pointed out that fertilizer requirement of the country was very large and country was very large and country resorted to substantial imports to fill up the demand supply gap. Also, there was import of raw materials and intermediate to manufacture phosphatic fertilizer. He underlined the need for increasing the production from the same resource use. He emphasized on the importance of improving efficiency to reduce the cost of production. This was necessary to make the fertilizer cheaper to the farmers and also to become competitive in the liberalized economic environment. He mentioned that advantage should be taken of developments in technology to produce better products, improve efficiency, improve safety of plants and conserve natural resources.

Awasti (1995), pointed out that the fertilizer plants are capital and energy intensive. These plants employ complex process and engineering technologies to manufacture a variety of products. He pointed out that the latest technologies must be employed to improve plant productivity. He urged the participants to derive maximum benefit from the presence of experts in various fields.

Sahi (1995), pointed out the increasing fertilizer nutrient imbalanced use is not conducive for sustaining agricultural productivity. He emphasized that priority should be given to balanced fertilizer use.

Shri Sajjam (1995), in his inaugural address in dealers training programme, organized by FAI on April 7, 1995, advised the dealers to remain in close touch with the farmers and educate them on balanced and efficient use of fertilizers. He stressed the need of giving right type of advice to the farmers who have faith on them. To get more business and faith from farming community, he urged the dealers to ensure availability of fertilizers, and not to indulge in any mal practices. He observed that to serve as better guide, it was pre-requisite to have latest information on various aspects of fertilizer and the
need based training programme would go a long way to benefit the fertilizer dealers and cooperative salesman.

Tewatia (1995), in his welcome address, he mentioned that the increasing problems of nutrient in balance demand and supply and quality control of fertilizer had increased the role and responsibility of fertilizer dealers. He felt that the dependence on balanced and increased use of fertilizer to improve the crop productivity would increase in future due to limited scope of increasing area under irrigation and HYVs.

Chaudhary (1995), in his inaugural address in the workshop on “Integrated plant nutrient supply system and increasing productivity”, organized at Sagar on 10 and 11 April 1995, stated that the lack of irrigation, lack of all weather communication system and huge financial need for making the fertilizer available in time and within easy reach of the farmers were a few of the hurdles coming in the way to increase food grain production in the state. Chaudhury requested the fertilizer manufacturers to stock fertilizers in the state well ahead of monsoon to ensure adequate supply.

**GENERAL-6-2**

**Consumption of Fertilizer**

Sen (1963) in his study ‘Use of fertilizer – A study in regional imbalances’ concluded there existed an inequality in the use of fertilizers in the south zone (Andhra Pradesh, Tamil Nadu, Karnataka and Kerala) and in the North zone (Punjab, Haryana and Himachal Pradesh). Both the zones showed a much higher intake of fertilizers as compared to their share of net area sown in the country. It was 22 per cent in south and 7 per cent in the North zone whereas, the percentage of fertilizer consumption was 33 and 15 per cent respectively. The percentage of net irrigated area was 53 per cent for north zone and per hectare use of fertilizer was 44.0 kg, whereas it was 23.4 per cent and 29 kg per hectare in the south zone. In the west zone, only 11.8 per cent area was net irrigated but the fertilizer
consumption was 15 kg. per hectare of cropped are. Highest fertilizer consumption districts of the country ranged between 50 kg and 130.0 kg as against the zonal average range of 12 kg and 44 kg per hectare.

Sharma (1973), ranked the different district of Rajasthan state on the basis of consumption of aggregate fertilizers per unit of cropped area and gross irrigated area. He observed that Sawai-Madhpur district had the highest consumption of aggregate fertilizer 0.47 kg. per hectare of cropped area while Sikar district had the lower consumption (0.013 kg per hectare) in 1960-61. Sawai Madhopur district was also ranged first with respect to consumption of aggregate fertilizer per hectare of gross irrigated area (2.92 kg) and Jaipur district was at the bottom (0.2 kg) per hectare of gross irrigated area during 1960-61.

Singh (1985) conducted a study on “A economic study of fertilizer demand in Rajasthan”. He observed that the consumption of aggregate fertilizer was highest in Sriganga Nagar district and lowest in Chura district during the period, i.e., 1967-68 and 1981-82. Sriganga Nagar district had the highest consumption of fertilizer (4.84 kg per hectare of cropped area) during 1987-88, but during 1981-82, Bundi district was at the top (27.88) kg per hectare of cropped area.

Anonymous (1992), reported that the consumption of fertilizer in India per unit area was low as compared to other countries. In 1990-91, the consumption of nitrogen in India was 43.8 kgs per hectare as compare to 309.5 kgs in Egypt, 332 kgs in Korea, 138.2 kgs in Japan, 196.2 kg in China and 129.3 kgs in Israel. At present 70 per cent of our land are unirrigated and depend on the vagaries of monsoon for water supply. The present estimate is that the full irrigation potential of the country will be developed only by 2010 A.D. It is assumed that the consumption of N, P₂O₅ and K₂O will increase to 150 kg per hectare of the irrigation potential of the country as against 404 kg in Egypt, 417 kg in Japan, 407 kg in Korea and 269 kg in China. The consumption requirement of 175 million hectares of cropped area in India
would be as large as 260 lakh tones as against the present consumption of 80 lakh tones.

Tiwari and Lahri (1992), concluded that there was a vide variation in fertilizer consumption as well as in its distribution in different agro-climatic regions of the country, which clearly indicates that without proper distribution or availability, the consumption does not stand anywhere. The trend in 1988-89 showed that fertilizer consumption in lower, middle and upper and transgangetic plains ranged between 0.57 and 1.67 million tones which were in order of transgangetic plains middle and lower gangetic plains.

Meena (1989), reported that the average extent of aggregate fertilizer (N+P+K) utilization by the farmers of Jaipur district in the year 1988-89 was 32.3 kg per hectare. The extent of nitrogen utilization was 12.93 kg per hectare, phosphate utilization was 6.72 kg per hectare and of potash was 2.69 kg per hectare. The extent of fertilizer utilization for small farmers in the year 1988-89 was 26.3 kg per hectare (N 19.49 kg + P$_2$O$_5$-3.58 + K$_2$O-1.37 kg per hectare). For medium farmers was 34.5 kg per hectare (N-24, 10 + P$_2$O$_5$-7.08 + K$_2$O-3.41 kgs per hectare) and for large farmers was 49.84 kg per hectare (N-33.63 kg + P$_2$O$_5$-10.40 kg + K$_2$O – 5.81 kg per hectare)

Subramaniyam and Nirmala (1991), conducted a study on “Factors affecting fertilizer demand at macro level” for the period 1966-67 to 1985-86 for India. It was concluded that when price of fertilizer is raised by 10 per cent, there was a 4.26 per decrease in the consumption of fertilizer is raised by 10 per cent there was a 4.26 per cent decrease in the consumption of fertilizers. The coefficient of irrigated area indicated that 10 per cent increase in irrigated area resulted in 14.38 per cent increase fertilizer use and for 10 per cent increase in the area under high yielding varieties, the increase in fertilizer demand was less than one percent. In short run, fertilizer demand increased by 13 per cent and in long run 13 per cent in response to a 10 per cent increase in its real price.
Pal and Singh (1992), in their study on “Fertilizer availability, prices and distribution” explained that problems of the farmers which affected the fertilizers consumption include the high cost of fertilizer, non availability of fertilizer in interior part of the country and lack of credit facilities.

**GENERAL—6-3**

**Economic response of fertilizer use**

Singh and Pandey (1981), conducted a study in Haryana state to estimate the relationship between per hectare output of crops (wheat, paddy and bajra) and quantities of nitrogen and phosphorus applied in producing the crops. They fit Cobb-Douglas production function for the purpose. The result showed that the marginal value productivity (MVP) of nitrogen applied to wheat, paddy and bajra were respectively Rs. 18.65, Rs. 8.13 and Rs. 17.28 per kg. Similarly, the MVPs of phosphorus in case of wheat and paddy were respectively Rs. 25.51 and Rs. 17.73 per kg. Thus, the MVPs of nitrogen and phosphorus were considerably greater than their respective prices in all crops.

Gupta et al (1986), analysed the extent of manures and fertilizer used and their productivity on the small farms of Gurgaon district of Haryana. They observed that the share of manures and fertilizers in the total cost of cultivation on the whole was observed to be less than 20 per cent and decreased with an increase in the size of farm.

Azad et al (1986), estimated the extent of farm income which would be maximized by optimum use of fertilizer and irrigation under capital constraints. Cobb-Douglas production function was fitted to determine the elasticity of production and for maximization of production of main crops at optimum level of independent input variables under capital constraints. The yields of maize, paddy, wheat and mustard could be maximized from their existing level of 16.13, 25.31, 30.05 and 10.15 quintals per hectare to 24.55, 25.31, 30.05 and 10.15 quintals per hectare respectively.
47.48, 40.17 and 21.53 quintals per hectare respectively. The net difference in the yield and value of output per hectare in maize, paddy, wheat and mustard between their existing and optimum levels of independent input variables was observed to be 8.12, 11, 17, 10.42 and 9.61 quintals and in terms of money to Rs. 1136.80, Rs. 1586.14, Rs.1625.94 and 4114 per quintal respectively. The study concluded that net income could be raised by simply re-allocation of available funds on the farm and with the technique of optimization of farm resources.

Sherikhant and Acharya (1989), conducted a study of farms in Rajasthan canal project area. By using Cobb-Douglas production function, they worked out the MVP-FC ratios which revealed that efficiency on the farms could be increased to a higher level. Return from investment on the farm labour and farm power was Rs. 1.47 to 3.61 per rupee while from irrigation and manure and fertilizer were 23.9 to 2.67 per rupee investments on these variables. This indicated the scope to increase the yield and income on the farms.

**GENERAL - 6-4**

**Education**

Bose, et al (1962), reported that the farmers of improved farm practices were better educated. Like wise Reddy (1962), Rai (1965), Reddy and Singh (1965), Bhatiya (1974), Singh and Magalwade (1978), Sharma (1983) and Sharma (1989), reported positive relationship between education and adoption. Singh and Sharma (1996), found positive and significant correlation between education and adoption behaviour of the farmers.
Sharma (1998) reported that there is positive and significant relationship between the sources of information utilized with adoption of improved package of practices.

Rogers (1962) reported that social status may either in habit or acquired enhances a persons adoption behaviour. It refers to the position of a farmer occupies in comparison to others with respect to possession of land, type of house, material possession, farm power and social participation. Studies of Wilkening (1953), Fligel (1956), Bakshi (1960), Vishnal and Bose (1962), Bose et al (1963) and Singh (1965) revealed that economic status was found to be positively correlated to adoption.

Gupta et al (1965), obtained positive and significant value of correlation between index and four out of six socio economic characteristics of the adopters viz., literacy status, economic status, social participation and size of holdings.

Ernest (1973), has shown that socio-economic status have direct bearing of adoption behaviour.

Jha and Shrikawat (1972) and Chandure (1973), concluded that economic condition of farmers always played dominant role in the acceptance of an innovation. Farmers with higher income and better economic status were early and high level adopters.

Singh and Sharma (1990), found that socio economic status was positively and significantly correlated with adoption behaviour of the farmers.


Reason for non adoption for improved practices

Roy (1966), reported that lack of conviction about utility of improved practices, lack of irrigation facilities and high initial cost of agricultural innovation were the major factors associated with the level of adoption of improved agricultural practices.

Singh (1968), found that reasons for non adoption of improved farm practices by the small farmers were lack of knowledge, lack of resources, lack of innovation, lack of attractive market and reasonable prices.

Jaiswal (1966), reported that lack of farming sources and irrigation facilities were the important factors attributed by field extension workers and farmers for non adoption of improved farm practices.

Patel (1967), pointed that one of the most important reasons for non adoption of modern technology by small farmers were lack of adequate knowledge and skill in agricultural technology.

Nair (1969), reported that high cost of fertilizer, untimely and inadequate supply of fertilizers were important problems of the farmers for partial adoption.

Pathak and Dargan (1971), found that non adoption attitude of the farmers was due to lack of timely supply of improved seeds and fertilizers along with their low purchasing power, lack of adequate information in respect with improved varieties and higher cost of improved seeds and fertilizers.

Patni (1979), found that lack of knowledge and unavailability of important inputs were the main cause for non adoption of many of the improved agricultural practices particularly those which require at high cost in bajra cultivation.
Saranaval (1982), found that unavailability of HYV of seeds within easy reach and lack of irrigation facilities were the major constraints in adoption of improved seed and recommended irrigation doses respectively. Lack of knowledge was also observed major constraint responsible for non adoption of recommend depth of planting, seed rate, seed treatment, irrigation schedule, recommended application of fertilizers and chemical weed control.

Sharma (1983), reported that the main handicap for non-adoption of improved practices were lack of irrigation, investment of production oriented inputs, lack of knowledge of improved seeds and utilization of recommended doses of fertilizers.

Bangarva (1985), observed that high cost of fertilizers and lack of irrigation facilities were the main problems responsible for non adoption of recommended doses of chemical fertilizers in wheat production.

Krishnaveer (1988), observed that lacking proper knowledge regarding the doses, methods and time of fertilizer application in the cultivation of wheat and bajra as well as the cost of fertilizers and lack of irrigation facilities might be the constraints.

Singh and Sharma (1990), stated the constraints in the adoption of improved practices of wheat cultivation were observed to be lack of finance for purchase of inputs (84 per cent), lack of knowledge and education, (81.7 per cent), high cost of HYV seeds (75.09 per cent) and shortage of irrigation facilities (61.0 per cent). Other constraints included non-availability of input at time (58.76 per cent) followed by low preferability of HYV seeds (50 per cent), incidence of pest and disease (48 per cent).