A STUDY ON THE YIELD RATES OF HIGH YIELDING VARIETIES OF MAJOR CEREAL CROPS

BY

M. S. AVADHANI[1] AND V. N. AMBLE[2]

1, INTRODUCTION

The results of a study carried out on the yield rates of high yielding varieties of paddy, wheat, maize, jowar and bajra with the help of the data on simple fertilizer trials available in the reports (Cf. [1] and [2]) on the subject prepared by the Indian Council of Agricultural Research, New Delhi, are presented here. The results no doubt pertain to only two years and are therefore to be taken as indicative rather than firm estimates. In the absence of any other information on experiments on high yielding varieties' performance in farmers' fields, this is the only basis to go by.

2. NATURE OF THE BASIC DATA

Simple fertilizer trials on cultivators' fields have been conducted in India since 1953 with a view to evaluating responses at varying levels of nitrogen, phosphorus and potash applied separately and in combination, and studying relative responses on various soil types so as to work out the most profitable fertilizer schedule for each of the broad soil classes in the country. To start with these trials were confined mostly to paddy and wheat, but subsequently their scope and coverage were extended to secure specific information on several aspects of fertilization. However, it was only from the year 1967-68 that the programme was modified to include the study of fertilizer responses of high yielding varieties.

The experimental programme for the simple fertilizer trials on cultivators' fields conducted during Kharif and Rabi 1967-68 and 1968-69 was drawn up at the annual work shop of agronomists, soil

1. Indian Society of Agricultural Statistics, C/o, I.A.R.S., New Delhi.
2. Central Statistical Organisation, New Delhi.

scientists, statisticians and agricultural engineers held at Hyderabad during June 1967. The emphasis in this programme was to obtain information on responses of the newly introduced dwarf/hybrid/exotic varieties of cereals to fertilizers and also to collect similar information on locally improved varieties of important cereals, cash and oil seed crops. The experimental programme consists of two parts, *viz.*, trials on high yielding varieties and trials on existing varieties. The trials were spread in all over 90 districts in the country ; high yielding varieties were included in 30 of them. Two types of trials, A and B, were conducted on paddy, wheat, maize, jowar and bajra under the high yielding varieties programme. The objective of the type A trials was to study the responses of high yielding varieties of the cereal crops in question to nitrogen (N) and phosphorus (P), individually and in combination, and to potash (K) in the presence of N and P. The objective of the type B trials was to bring out the comparative performance of the newly introduced dwarf/hybrid/exotic varieties vis-a-vis the locally improved varieties in the presence of N, P and K. Data obtained in type A trials carried out on high yielding varieties were used in the present study to examine the fertilizer response for different crops.

The treatments, *viz.*, combinations of different levels of the nutrients, N, P and K used in type A trials were as follows :—

$$0,\ N_1,\ N_2,\ P_1,\ N_1P_1,\ N_1P_2,\ N_2P_1,\ N_2P_2,\ N_2P_2K_1,\ N_2P_2K_2$$

or

$$0,\ N_1,\ N_2,\ P_1,\ N_1P_2,\ N_1P_4,\ N_2P_2,\ N_2P_2,\ N_2P_1K_1,\ N_2P_1K_2$$

which differ only in respect of the last two combinations. Here "0" denotes no fertilizer treatment and

	$N_1=60$ kg/ha of N	$N_2=120$ kg/ha of N
	$P_1=30$ kg/ha of P_20_5	$P_2=60$ kg/ha of P_20_5
and	$K_1=30$ kg/ha of K_20	$K_2=60$ kg/ha of K_20

Average yield rates of untreated plots and the responses of different varieties of crops to various treatments were tabulated season-wise and district-wise according to the soil groups. The results presented in the 10th Annual Report in Tables II—IV and the 11th Annual Report in Tables 1.1.1, 1.1.2 and 1.2.1—1.5.1 which pertain to type A trials on high yielding varieties constitute the main basis of the present investigation.

The results concerning the relationship between the inputs, or fertilizers, and the outputs, or yield rates, of different crops are discussed in the following section,

3. Input-output relationships for major cereal crops

Let x_1 and x_2 be two variables defined on the levels of the nutrients N and P respectively such that

$$1 \text{ unit of } x_1 = 30 \text{ kg/ha of } N$$

and
$$1 \text{ unit of } x_2 = 30 \text{ kg/ha of } P_2O_5.$$

The yield rates (y in Q/ha) of a given variety of a crop under the treatments O, N_1, N_2, P_1, N_1P_1, N_2P_1, N_1P_2 and N_2P_2 are the values of a function defined over the set of points (x_1, x_2) where $x_1=0, 2, 4$ and $x_2=0, 1, 2$ such that when $x_1=0$, $x_2 \neq 2$ and when $x_2=2$, $x_1 \neq 0$. Consequently, the problem of investigating the input-output relationship for a given variety on the basis of the information available on the triplets (y, x_1, x_2) amounts to studying the regression of y on x_1 and x_2.

Attempt was made with the help of the method of least squares to fit to y the linear or quadratic, in x_1 and x_2. The simplest function which explained about 85 per cent of variation or more was taken to study the relationship between y and x_1, x_2.

The regression of y on x_1 and x_2 was worked out for each variety within a given soil group by first averaging the yield rates of the variety in question corresponding to a given fertilizer treatment over all districts within the soil group taking the number of experiments in the districts as weights The homogeneity or otherwise of the response relationships for a given variety of a crop in different soil groups within a year and between years within a soil group was tested utilising the procedure given by Rao (1965, [5]). The equations were found to be different in all cases. The results thus obtained are described in the following sub-sections according to crops and varieties within crops.

3.1. Paddy (Kharif and Rabi 1967-68 and 1968-69)

Although the fertilizer trials were conducted in both Kharif and Rabi 1967-68 and 1968-69 in irrigated or assured rainfall (where rainfall exceeds 90 cms) areas, data were recorded separately for irrigated and rainfed crops only for the latter year.

Trials on paddy were spread over nine districts in both the years in Kharif season but the number of experiments on which available data were based was 683 in 1967-68 and 618 in the latter. The information available on Rabi paddy during 1967-68 was based on 254 experiments conducted in four districts and during 1968-69 it was based on 390 trials spread overs ix districts. Although the high yielding exotic varieties *IR*-8 and *TN*-1 were tried in both the years, Taichung-65 was tried only in 1967-68. The improved local varieties such as *ADT*-27, *CO*-25, etc., were tried in both the years but in some cases data were not recorded separately for the classified locals in either or both the years. In determining the input-output relationships in different soil groups by the procedure described in the preceding discussion the individual varietal distinction was maintained wherever it was feasible. The results are presented in Table 1.

It is seen from Table 1 that the linear function in x_1 and x_2 accounted for more than 85 per cent of variation in the case of all exotic varieties in all soil groups and in both Kharif and Rabi 1967-68 and 1968-69, excepting *TN-I* in red and yellow soil for which in Rabi 1968-69 quadratic had to be taken to account for about 85 per cent of the variation. In the case of classified local varieties also the input-output relationship was linear, accounting for more than 90 per cent of variation, in all soil groups and in both the years, with the exception of *ADT*-27 in medium black soil in Kharif 1967-68 where even the quadratic explained about 67 per cent of variation, *PTB*-10, Safri-17 in red and yellow soil in Kharif 1968-69 and the "improved local" in coastal alluvium soil in Rabi 1968-69, where in all these three cases only quadratic was found to explain more than 90 per cent of variation.

3·2. *Wheat*

The information available on the yield rates of different varieties of wheat in 1967-68 and 1968-69 was based on the results of 322 and 904 experiments conducted in six and fourteen districts respectively. Whereas the dwarf varieties grown in the experiments in 1967-68 were *PV*-18, Sonora-64 and Lerma Rojo, those grown in 1968-69 were Kalyan Sona (*S*-227), Sonalika (*S*-308) and Lerma Rojo. The local tall verieties tried in both the years included *NP*-824, *C*-306, *Pb*-591, etc. The functional relationships between the yield rates and the inputs x_1 and x_2 are shown in Table 2.

The input-output relationship for all varieties in all soil groups was linear, accounting for more than 90 per cent of variation in both the years, excepting in the case of Lerma Rojo in 1967-68 and *S*-308 in 1968-69 in medium black soil and improved local in grey brown soil in 1968-69 where the quadratic explained about 90 per cent of variation or more. It may be pointed out that excepting the local tall variety *NP*-824 no other variety was tried in the same soil group in both the years. In the case of *NP*-824, whereas the relationship was linear in 1968-69, accountiug for about 96 per cent, even the quadratic explained only about 69 per cent of variation in 1967-68.

3·3. *Maize*

Data of 219 trials spread over three districts in 1967-68 and 242 experiments conducted in five districts in 1968-69 constitute the main basis of the information used for the present study. The hybrids grown in 1967-68 were Ganga-3 and Ganga Safed-2 and those grown in 1968-69 were Ganga-2, Ganga-3, Ganga-5, and Deccan. The local varieties sown were Jaunpur, T-41 and others. Multiple regressions of y on x_1 and x_2 were determined separately for each variety in all soil groups and in both the years.

It was found that in all cases linear accounted for about 92 or more per cent of variation. The equations of the input-output relationships are shown in Table 3 together with the percentage variation explained by them. Of all the varieties grown only Ganga-3 was tried in both the years under the same soil group and the same season. In both cases the relationship was linear but the rate of response to x_1 and x_2 in 1968-69 was slightly smaller than in 1967-68.

3·4. *Jowar*

During 1967-68 results from 16 trials conducted in Banda district of Uttar Pradesh in Kharif and 25 trials conducted in Nizamabad district of Andhra Pradesh constitute the main basis of the yeild rates used for the present study. In 1968-69, however, data of 263 experiments spread over five districts conducted under irrigated and rainfed conditions were available. The hybrids tried were *CSH*-1 and *CSH*-2. The input-output relationships were determined as before separately in both the years and are presented in Table 4 together with the percentage variation explained by them. The production function was linear in all cases excepting in the case of *CSH*-2 and *M*-351 in medium black soil during Rabi 1968-69, where it was quadratic. Of all the varieties sown only *CSH*-1 was tried in the same soil group (medium black soil) in the same season and in both the years. In this case the production function was linear in both the years but the production differed considerably. Even the control plot yield in 1968-69 was about 50 per cent more than that in 1967-68. The rate of response to nitrogen was of the same order in both years but the rate of response to phosphorus in 1968-69 was considerably higher than in 1967-68.

3·5. *Bajra*

The yield rates of bajra in 1967-68 were based only on 42 trials conducted in the districts of Mehsana of Gujarat which belongs to greybrown soil and Aligarh of Uttar Pradesh which belongs to alluvial soil group. In 1968-69 also 108 trials were conducted in the same two districts under irrigated and rainfed conditions. The varieties included in the experiments were *HB*-1, *H*-115, *N*-207, etc. Production functions were determined for all varieties separately in both the years as before and the results are given in Table 5.

In all cases the relationships were found to be linear explaining about 90 or more per cent of variation. Of all varieties tried only *HB*-1 was sown in the same soil, in the same season and in both the years. In both cases the production function was linear and the productivity was of the same order.

4. COMMENTS

It is clear from the results presented in Tables 1—5 that the relationship between the inputs nitrogen and phosphorus and the yield rates of the newly introduced dwarf/hybrid/exotic varieties and the locally improved varieties of paddy, wheat, maize, jowar, and bajra was linear in the range of inputs tried in all soil groups and in both the years 1967-68 and 1968-69 with the exception of a few cases such as TN-1 in red and yellow soil in Rabi 1968-69, Lerma Rojo in medium black soil in 1967-68, *S*-308 in medium black soil in 1968-69, etc. in which it was quadratic. This shows that the effect of nitrogen and phosphorus on the productivity of the crops in question is additive in almost all soils within the range of inputs tried. It was interesting to find that as high a dose as 120 kg of N and 60 kg of P_2O_5 can be applied and yet the relationship is substantially linear. This is very promising in the context of population pressure on land in that it shows that there is ample room for achieving further successes in land productivity. Also, since any linear function does not have a maximum or minimum, the input-output relationships under consideration do not possess a maximum output "point" and consequently no fertilizer schedule giving rise to maximum production can be recommended from the present results. In order to do so it will be necessary to extend the range of doses of nitrogen and phosphorus in the experiments. However, the production functions given in Tables 1 – 5 can be made use of for obtaining estimates of production for specified doses of the nutrients within the dose range tried. Further, in the absence of any knowledge about the extent of area which can be brought under each variety of the crops in each soil group one has to go by the less precise overall yardsticks which may be obtained from the production functions in the manner described in the following section.

5. Efficient Fertilizer Schedules and Optimum Yield Rates

Since agriculture is basically a business enterprise and the farmer adopts a certain fertilizer schedule provided it is economically efficient in the sense that it enhances his profits, it is instructive to investigate the most profitable, or efficient, combination of the plant nutrients nitrogen (N) and phosphorus (P_2O_5) for different crops in different soil groups.

Assuming that the relationship between the value of the crop produce and the plant nutrient is a quadratic function Sukhatme (1941, [7]) deduced that the optimum dose of the input is given by the point at which the tangent to the production curve is parallel to the straight line representing the cost line of the variable input. This implies in the case of several variable inputs that, if $y=f(x_1, x_2,\ldots)$ is the functional relationship between the inputs x_i and the output y of the crop in question, P_{x_i} and P_y denote the price per unit of x_i and y so that P_{x_i} gives the slope of the cost line of the input x_i, then profits would be optimum when the dosages of x_i satisfy the simultaneous system :

$$P_y \frac{\partial y}{\partial x_i} = P_{x_i},\ i=1, 2,\ldots,$$

where the left side gives the slope of the tangent under reference. Also, it is clear that when the slope of the tangent exceeds P_{x_i} larger and larger profits accrue to the farmer with increasing dosages of x_i whereas the profits decline steadily as x_i increases when the reverse inequality holds good. Thus, when

$$P_y \frac{\partial y}{\partial x_i} > P_{x_i}$$

x_i should be increased to the maximum extent in order to ensure maximum profits and when

$$P_y \frac{\partial y}{\partial x_i} < P_{x_i}$$

then x_i should be applied to the crop at its minimum level possible. It may be added that this law which is known as the "law of economic efficiency" has been derived in a slightly different way in standard texts on economics (cf. Heady, 1952, pp 98-105, [4]).

For applying the preceding law to determine the most efficient fertilizer schedules for the different varieties of the various crops under study it is necessary to determine the price ratios P_{x_i}/P_y in respect of the inputs N and P_2O_5 and the outputs of different varieties of crops in question. For this purpose the weekly whole-sale prices of different high yielding varieties of rice, wheat, etc. in different *mandis* available only for the year 1968 in the Directorate of Economics and Statistics, Ministry of Food and Agriculture, Government of India, New Delhi, and the State-wise recorded monthly prices of different nitrogenous, phosphatic and complex fertilizers available for the year 1966-67 in Fertilizer Statistics 1966-67 were utilized. From the weekly prices of different variety-wise classified agricultural commodities in different *mandis* the average price per quintal of different varieties of the commodities in the country was computed first by averaging over all weeks in a *mandi* and then over all *mandis*. Again, from the available State-wise recorded monthly price rates of fertilizers for 1966-67 the average price per metric tonne of each fertilizer in the country was calculated by averaging first over months within States and then over all the States in the country. From the average price rates P_i of fertilizers thus obtained and the supplies Q_i of different fertilizers to farmers in 1966-67 (as given in Fertilizer Statistics, 1966-67, [3]) the weighted average price per metric tonne of the plant nutrients N and P_2O_5 were calculated by making use of the following formulae :

Price per metric tonne of N $= \left[\sum_i Q_i P_i \left(\frac{a_{i_1}}{\sum_j a_{i_j}}\right)\right] \Big/ \sum_i Q_i a_{i_1}$

and price per metric tonne of P_2O_5 $= \left[\sum_i Q_i P_i \left(\frac{a_{i_2}}{\sum_j a_{i_j}}\right)\right] \Big/ \sum_i Q_i a_{i_2}$

where a_{i_j}, $j=1, 2, 3$, respectively denote the nutrient contents of N, P_2O_5 and K_2O in one unit of the ith fertilizer, so that $0 \leqslant a_{i_j} < 1$ and $\sum_j a_{i_j} > 0$ for all i, and the symbol $\sum_i$ denotes summation over all nitrogenous, phosphatic, and complex fertilizers. The price ratios in respect of the inputs N and P_2O_5 and the variety-wise outputs of different major cereals under consideration were then computed. The prices of the inputs and the outputs, and the respective price ratios thus obtained have been shown in Table 6.

For the purpose of determining efficient fertilizer schedules it may be noted that in all cases where the production functions are linear the marginal productivity of the inputs N and P_2O_5 in respect of different varieties of various crops under study are given by the respective regression coefficients of x_1 and x_2. Hence in view of the law of economic efficiency stated in the preceding discussion the 'optimum' dose of x_i for a given variety for which the production function is linear is given for the restricted range of doses tried, by the maximum of the dose range tried for x_i when Px_i/P_y given in Table 6 for the variety in question is smaller than the regression coefficient of x_i and it would be zero if the reverse inequality holds good. In all cases where the production functions are quadratic the first partial derivative with respect to x_i was equated to the corresponding Px_i/P_y given in Table 6 for $i=1$, 2 and the resulting linear system was solved for optimum values of x_1 and x_2. This procedure was adopted for all newly introduced dwarf/hybrid/exotic varieties with reference to the production functions referring to 1967-68 as well as 1968-69. However, in the case of wheat the input upon output price ratios were not available for the varieties designated by S-227 and S-308 due to lack of data. Since these two varieties belong to Sonora family, the price ratios referring to Sonora-64 were made use of for determining optimum doses of N and P_2O_5 for these varieties. Also, in the case of classified locals the respective price ratios were not available. But optimum dosages of N and P_2O_5 were determined in some of these cases as follows. Since the local varieties are likely to be more adapted for the local consumption than the newly introduced high yielding varieties, the prices of the former are likely to be higher than of the latter and consequently the corresponding price ratios of input to output for the local varieties would be smaller than those for the newly introduced varieties. Hence in a given soil group if the price ratios for any one of the new varieties were smaller than the corresponding marginal productivities of the inputs in respect of a local variety, then the restricted optimum dosages of N and P_2O_5 for the local variety would be given by the maxima of the ranges tried. Wherever this did not happen the dose was taken to be zero. This procedure could be adopted only in cases where the production functions were linear. Efficient fertilizer schedules thus determined are presented in Table 7.

It is seen from Table 7 that in almost all the soil groups and in both the years the optimum fertilizer schedule for most of the varieties of paddy, wheat and maize comprises 120 kg. of N and 60 kg. of P_2O_5 per hectare. However, in a few cases such as *IR*-8 and *TN*-1 in red and yellow soil sown in Rabi season under irrigated conditions, *IR*-8 under rainfed conditions in coastal alluvium soil, *S*-308 in medium black soil, the optium dosages of N and P_2O_5 are either zero N and 60 kg. P_2O_5, or 102 kg. N and 27 kg. P_2O_5 per hectare. Further, in respect of *CSH*-2, *CO*-18 and PJNK of jowar the optimum schedule consists of N and P_2O_5 in the ratio 9:2, 1:2 and 0:1 respectively. Also, in the case of bajra for *H*-115 under irrigated and rainfed conditions, and for *N*-207 under rainfed conditions the ratio under reference is 0:1.

Next, corresponding to the efficient dosages of N and P_2O_5 presented in Table 7 and to zero 'dose' of the fertilizer the yield rates of a given variety of a crop were computed in different soil groups from the respective production functions given in Tables 1-5. These rates were then averaged over all soil groups to get the corresponding overall yield rates of the variety in question taking the areas under the crop in different soil groups* in the country as weights. This exercise was repeated for all the newly introduced dwarf/hybrid/exotic and some of the improved local varieties of the cereal crops under study and the results thus obtained are shown in Table 8. Also, the responses of different varieties per kg. of plant nutrients, which consist of N and P_2O_5 in the same ratio as the efficient dosages of the nutrients, were worked out in a similar fashion and are presented in Table 8.

It is seen from Table 8 that of the varieties of paddy, *CO*-25 and ADT-27 produced larger yields per hectare, both with and without fertilizer, and under irrigated as well as rainfed conditions as compared with the other varieties including *I.R.*-8 and *T.N.*-1. Also in 1968-69 two other varieties, *G.E.B.*-24 and *M.T.U.*-3 were as good as *I.R.*-8 in respect of yield rates. The response per kg. of fertilizer (consisting of N and P_2O_5) of *CO*-25, *GEB*-24, *T.K.M*-.6, *I.R.*-8 and *ADT*-27 was 10 kg. or more and for the rest it was less than 10 kg. under irrigated conditions. But under rainfed conditions *A.D.T.*-27 gave larger response per kg. of nutrients than *CO*-25, and *I.R.*-8. It

*Areas under different crops in various soil groups in the country were broadly determined by first identifying all the districts in the country with their major soil groups as indicated by Raychaudhuri et al. (1963, [6]) and then cumulating the areas under the crops in the districts which belong to the respective soil groups.

must be remarked that *CO*-25, and *A.D.T.*-27 were tried only in certain areas where they were prevalent while the exotic varieties *I.R.*-8, *T.N.*-1 and Taichung-65 were sown in many paddy growing regions of the country. Nevertheless, the present study indicates that the improved local varieties under reference would be as good as the exotic varieties, if not better at least in the regions where they were in use. Perhaps their wider use could be explored.

Among the various varieties of wheat tried in 1967-68 and 1968-69 *P.V.*-18 was the highest producer yielding about 53q/ha. and 29 q/ha. with and without fertilizer respectively. However, *P.V.*-18 and *Sonora*-64 which were tried in 1967-68 were displaced in 1968-69 by Kalyan Sona (*S*-227) and Sonalika (*S*.-308). But, in so far as yields per hectare are concerned these did not compare well with *P.V.*-18. Lerma Rojo fared better in 1968-69 than in 1967-68. Of the varieties tried in 1968-69 *S*-227 was the best yielding about 22 q/ha. without fertilizer and 40 q/ha. with 120 kg. of *N* and 60 kg. of P_2O_5/ha. At the optimum level of application of fertilizers Lerma Rojo stood on par with the improved locals *Hy*-65 and *C*-306. But when no fertilizer was applied the local varieties *C*-306 and *N.P.*-824 gave better yields than Lerma Rojo. In respect of response per kg. of nutrients *Hy*-65 gave rise to the largest followed by *P.V.*-18, Lerma Rojo, Sonora-64 and *S*-227. The variety *Hy*-65 could therefore be termed to be at least as responsive to the application of fertilizer as *S*-227 and Lerma Rojo, if not better, in the regions in which it was tried. *S*-308 was quite poor in respect of yields/ha. as well as response per kg. of nutrients.

Of the varieties of maize Deccan was the most promising in all respects followed by Ganga-5 and Ganga-3 in that order. However, the latter two Ganga varieties were equally responsive to fertilizer. *C.S.H.*-1 was superior to all the other varieties of jowar yielding about 42q/ha. without fertilizer and 59 q/ha. with 120 kg. of *N* and 60 kg. of P_2O_5 per ha. under irrigated conditions. However, under rainfed conditions the improved local variety PJNK with only 60 kg. of P_2O_5 gave rise to almost the same yield as *C.S.H.*-1 with 120 kg. of *N* and 60 kg. of P_2O_5 per ha. As regards the varieties of bajra *H*-115 gave about 19 q/ha. under irrigated conditions with only 60 kg. of P_2O_5 per hectare as against 22 q/ha by *N*-207 with 120 kg. of *N* and 60 kg. of P_2O_5/ha. But under rainfed conditions *H*-115 does not seem to be quite responsive to fertilizer and it gave the same yield without fertilizer as *N*-207 with 60 kg. of P_2O_5 per ha. Thus *C.S.H.*-1 under irrigated conditions and H-115 under rainfed conditions without fertilizer seem to be quite remunerative.

6. Summary

All the data on the performance of high yielding varieties of paddy, wheat, maize, jowar and bajra referring to simple fertilizer trials on cultivators' fields available in the reports on the subject prepared by the Indian Council of Agricultural Research, New Delhi, were analysed and appropriate response relationships were determined year-wise for different varieties in different soil groups. It was found that the relationship between the inputs nitrogen and phosphorous and the yield rates of the high yielding varieties of the cereal crops in question was linear in the range of inputs tried in all soil groups and in both the years 1967-68 and 1968-69 with the exception of a few cases such as T.N.-1 in red and yellow soil in Rabi 1968-69, Lerma Rojo in medium black soil in 1967-68, S-308 in medium black soil in 1968-69, etc., in which it was quadratic. It was interesting to find that as high a dose as 120 kg. of N and 60 kg. of P_2O_5 can be applied and yet the relationship is substantially linear. This is very promising in the context of population pressure on land in that it shows that there is ample room for achieving further successes in land productivity.

Utilising the law of economic efficiency in conjunction with the response relationships optimum fertilizer schedules for different varieties in different soil groups were determined. Yield rates of each of the newly introduced high yielding varieties as also of some of the improved local varieties corresponding to the optimum dosage and without fertilizer, and response per kg. of nutrients which comprises N and P_2O_5 in the same ratio as in the optimum dosage were worked out together with their standard errors. The results do not show substantive evidence, at least in the dose range tried, in favour of the statement that the newly introduced dwarf/hybrid/exotic varieties of the crops in question are more responsive to fertilizer at higher levels than the improved local varieties. In actual fact the converse was found to hold good within the dose range tried at least in the areas where some of the improved locals such as ADT-27, Co-25 of paddy, Hy-65 of wheat, etc., were prevalent.

7. Acknowledgements

This work was carried out in connection with the Research Project taken up by the Indian Society of Agricultural Statistics, which is being financed by the Government of India through grants-in-aid. The authors are indebted to the Indian Council of Agricultural Research and Institute of Agricultural Research Statistics for permitting the use of the results of simple fertilizer trials on cultivators' fields presented in the 10th and 11th annual reports. Data on weekly wholesale prices of high yielding varieties of the cereal crops were collected from the Directorate of Economics and Statistics, Ministry of Food and Agriculture, Government of India, New Delhi.

We are grateful to Dr. P. V. Sukhatme, Director, Statistics Division, F.A.O., Rome, for going through the article critically. The computational assistance rendered by Shri Shachindra Sharma is thankfully acknowledged.

REFERENCES

[1] Annual Report of the All India Coordinated Agronomic Experiments Scheme, Vol. 5, Kharif and Rabi 1968-69, Indian Council of Agricultural Research, New Delhi, and Cooperating Agencies.

[2] Coordinated Agronomic Experiments Scheme, Results of Simple Fertilizer Trials on Cultivators' Fields, Kharif and Rabi 1967-68, Indian Council of Agricultural Research, New Delhi.

[3] Fertilizer Statistics 1966-67, The Fertilizer Association of India, New Delhi.

[4] Heady, Earl O. (1952): Economics of Agricultural Production and Resource Use, Prentice Hall, Inc., New York.

[5] Rao, C.R. (1965) : Linear Statistical Inference and Its Applications, John Wiley, New York.

[6] Raychaudhuri, S.P., *et al.* (1963) : Soils of India, Indian Council of Agricultural Research, New Delhi.

[7] Sukhatme, P.V. (1941) : Economics of Manuring, Indian Journal of Agricultural Science, Vol. XI, pp 325-337.

TABLE 1

Input-Output Relationships for Different High Yielding Varieties of Paddy Sown in Kharif and Rabi 1967-68 and 1968-69

Year and Season		*1967-68*	*Kharif*	*1968-69*	
Soil Group	*Variety*	*Relationship*	*Variation explained (%)*	*Relationship*	*Variation explained (%)*
(1)	(2)	(3)	(4)	(5)	(6)
Alluvial	TN-1	$y=21.92+3.07x_1+2.66x_2$	99	$y=18.96+2.87x_1+1.57x_2$	97
	IR-8			$y=25.63+3.58x_1+2.48x_2$	99
	Locals	$y=19.41+2.05x_1+1.61x_2$	98		
	BR-34			$y=20.66+3.36x_1+1.87x_2$	92
	N-22			$y=13.01+1.58x_1+0.80x_2$	94
	Jona-349			$y=24.99+2.93x_1+2.83x_2$	97
	NSJ-200			$y=15.47+1.75x_1+1.30x_2$	97
Coastal Alluvium	IR-8	$y=35.99+3.57x_1+4.51x_2$	99	$y=29.75+2.94x_1+4.36x_2$	97
	CO-25	$y=40.92+2.85x_1+2.24x_2$	97		
	ADT-27			$y=32.41+2.89x_1+4.34x_2$	97
	PTB-10			$y=7.37+1.29x_1+1.14x_2$	98
Red Soil	IR-8			$y=33.06+3.07x_1+3.54x_2$	99
	Taichung-65	$y=20.54+1.34x_1+4.41x_2$	93		
	Locals	$y=20.12+1.00x_1+2.97x_2$	91		
	GEB-24			$y=28.93+3.44x_1+3.52x_2$	94
	TKM-6			$y=25.63+3.10x_1+3.95x_2$	98
	Locally Improved			$y=26.90+1.71x_1+1.33x_2$	97

TABLE 1 (*Continued*)

Year and Season		*1967-68*	*Kharif*	*1968-69*	
Soil Group	*Variety*	*Relationship*	*Variation explained %)*	*Relationship*	*Variation explained (%)*
(1)	(2)	(3)	(4)	(5)	(6)
Medium black	IR-8	$y=4[illegible].83+1.95x_1+2.91x_2$ *	95	$y=51.27+3.26x_1+5.52x_2$	98
	ADT-27			$y=43.40+2.65x_1+4.[illegible]5x_2$	98
	MTU-3			$y=30.37+2.46x_1+3.26x_2$	97
Laterite	TN-1	$y=17.72+1.49x_1+2.52x_2$	98		
	Locals	$y=22.83+1.34x_1+2.54x_2$	97		
Black Soil	IR-8			$y=24.39+2.17x_1+3.48x_2$	86
	SLO-13			$y=19.36+1.06x_1+2.10x_2$	89
Red and Black	IR-8	$y=33.43+2.52x_1+2.57x_2$	91		
	Locals	$y=32.17+1.58x_1+1.30x_2$	99.7		
Red and Yellow	IR-8			$y=25.54+1.90x_1+2.00x_2$	86
	PTB-10			$y=13.84+0.50x_1+4.61x_2+0.07x_1^2-0.12x_1x_2-1.51x_2^2$	92
	Safri-17			$y=25.68+3.59x_1+10.55x_2-0.24x_1^2-1.21x_1x_2-1.76x_2^2$	98

*Even quadratic explained only about 67 per cent of variation in this case.

TABLE 1 (*continued*)

Season and Year		*1967-68 (irrigated or with assured rainfall)*		*Rabi*	*1968-69 (Irrigated)*
(1)	(2)	(3)	(4)	(5)	(6)
Alluvial	IR-8			$Y=29.86+3.32x_1+3.17x_2$	98
	CO-25			$Y=33.70+3.43x_1+4.30x_2$	99
Coastal Alluvium	IR-8	$Y=23.58+2.44x_1+2.87x_2$	99		
	Locals	$Y=24.54+2.26x_1+2.46x_2$	99		
Red Soil	IR-8			$Y=31.47+2.92x_1+3.35x_2$	98
	ADT-27			$Y=36.80+1.68x_1+2.30x_2$	92
	Improved Local			$Y=31.83+2.51x_1+2.25x_2$	99
	CO-25 & BCP-1			$Y=29.12+2.35x_1+2.08x_2$	98
Black Soil	IR-8			$Y=28.61+1.60x_1+4.33x_2$	91
	CH-45, SLO-16 & 19			$Y=17.81+1.70x_1+2.78x_2$	96
Red and Black	IR-8	$Y=42.15+2.35x_1+2.67x_2$	94		
	TN-1	$Y=45.10+1.85x_1+2.72x_2$	98		
	Locals	$Y=35.79+1.43x_1+1.83x_2$	95		
Red and Yellow	IR-8	$Y=22.47+0.97x_1+3.74x_2$	94		
	TN-1	$Y=27.55+1.31x_1+5.06x_2$	87	$Y=32.57+4.37x_1+10.83x_2 -0.42x_1^2-0.58x_1x_2+4.06x_2^2$	85
	Locals	$Y=20.05+2.01x_1+1.92x_2$	89	$Y=28.70+2.28x_1+3.37x_2$	87
	PTB-10			$Y=19.84+0.89x_1+1.85x_2$	91

TABLE 1 (*continued*)

Year and Season		*Rabi*	*1968-69 (Rainfed)*
Coastal Alluvium	IR-8	$Y=31.12+0.98x_1+2.10x_2$	93
	Improved Locals	$Y=18.32+2.09x_1+1.88x_2$ $-0.20x_1{}^2-0.59x_1x_2+0.24x_2{}^2$	99
	PTB-24	$Y=19.84+0.89x_1+1.85x_2$	91
Red Soil	IR-8	$Y=37.72+3.18x_1+4.06x_2$	99
	ADT-27	$Y=36.62+3.04x_1+3.58x_2$	99
Red and Laterite	IR-8	$Y=36\ 19+2.65x_1+2.52x_2$	98
	CO-25	$Y=43.00+1.52x_1+2.26x_2$	91
	PTB-10 & 12	$Y=29.42+1.11x_1+0.76x_2$	91

Scale: y in quintals per hectare, 1 unit of $x_1=30$ kg of N/hectare and 1 unit of $x_2=30$ kg of P_2O_5/ha

TABLE 2

Input-output Relationships for different High Yielding Varieties of Wheat

Year		*1967-68*		*1968-69*	
Soil Group	*Variety*	*Relationship*	*Variation explained (%)*	*Relationship*	*Variation explained (%)*
(1)	(2)	(3)	(4)	(5)	(6)
Alluvial	PV-18	$y=29.12+4.34x_1+3.23x_2$	98		
	Sonora-64	$y=20.39+3.47x_1+2.37x_2$	99·6		
	S-227			$y=23.68+3.05x_1+3.18x_2$	99
	S-308			$y=14.26+1.87x_1+1.46x_2$	99
	Lerma Rojo			$y=16.27+3.66x_1+2.61x_2$	99
	Locals	$y=18.75+2.40x_1+2.23x_2$	99		
	C-306			$y=20.08+2.00x_1+3\ 23x_2$	98
	K-68			$y=16.76+2.07x_1+1{\cdot}55x_2$	99
	Pb 591			$y=17.25+2.61x_1+1.98x_2$	99
	NP-824			$y=22.65+1.20x_1+1.66x_2$	98
	NP-884			$y=13.70+2.64x_1+1.94x_2$	99
	Np-710, 50			$y=17.33+1.95x_1+1.68x_2$	91
Medium Black	Lerma Rojo	$y=13.03+1.02x_1+2.17x_2 -0.19x_1^2+0.04x_1x_2-0.67x_2^2$	89		

Table 2 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)
Medium Black (contd.)	S-308			$y=11.64+1.11x_1+3.99x_2+0.12x_1^2-0.06x_1x_2-1.18x_2^2$	99
	NP-824	*		$y=13.97+0.53x_1+1.61x_2$	96
Deep Black	S-227			$y=14.82+3.86x_1+4.54x_2$	97
	Hy-65			$y=11.47+3.69x_1+5.65x_2$	92
Red and Black	Lerma Rojo	$y=13.78+1.69x_1+1.63x_2$	99		
	S-227			$y=15.57+1.90x_1+1.39x_1$	99
	Locals	$y=11.86+1.45x_1+1.48x_2$	98		
	K-68			$y=15.37+1.67x_1+1.47x_2$	99
	Improved Locals			$y=11.31-1.10x_1+1.07x_2$	99
Grey Brown	S-227			$y=17.18+1.14x_1+0.96x_2$	91
	RS-31			$y=15.27+1.27x_1+1.27x_2$	98
	Improved Locals			$y=15.21+1.05x_1+5.85x_2-0.16x_1^2+0.31x_1x_2-2.30x_2^2$	90
Red Soil	S-227			$y=14.58+1.86x_1+2.78x_2$	96
	S-308			$y=11.44+2.86x_1+1.79x_2$	97
	NP-824			$y=8.16+1.39x_1+1.13x_2$	98

Scale : For y, x_1 and x_2 is the same as in foot-note under Table 1.
S-227 and S-308 are otherwise known as Kalyansona and Sonalika respectively.

*Even quadratic explained in this case only about 69 per cent of variation.

TABLE 3

Input-Output Relationships for Different High Yielding Varieties of Maize

Year and Season		*1967-68 Kharif (Irrigated or with assured rainfall)*		*1968-69 (Irrigated)*	
Soil Group	*Variety*	*Relationship*	*Variation explained (%)*	*Relationship*	*Variation explained (%)*
(1)	(2)	(3)	(4)	(5)	(6)
Alluvial	Ganga-2			$y=14.76+1.33x_1+1.27x_2$	92
	Ganga-3	$y=22.71+2.60x_1+1.98x_2$	99.7	$y=21.24+2.32x_1+1.60x_2$	98
	Ganga Safed-2	$y=14.97+2.40x_1+1.84x_2$	98		
	Ganga-5			$y=27.73+2.62x_1+2.52x_2$	96
	Locals	$y=15.74+2.08x_1+1.64x_2$	99		
	Jaunpur			$y=12.08+1.13x_1+0.96x_2$	97
	Improved Locals			$y=21.08+2.15x_1+1.86x_2$	98
	Year			1968-69 (Rainfed)	
Alluvial	Ganga-3			$y=18.75+2.09x_1+1.32x_2$	99
	Improved Locals			$y=14.69+2.12x_1+1.09x_2$	99 7
Hilly Soil	Ganga-3			$y=13.99+1.53x_1+2.33x_2$	97
	Improved Locals			$y=11.43+1.44x_1+1.42x_2$	99
	Season			Rabi 1968-69 (Irrigated)	
Medium Black	Ganga-3			$y=9.67+3.29x_1+2.77x_2$	97
	Deccan			$y=29.39+2.49x_1+3.12x_2$	95
	Improved Locals			$y=15.65+2.35x_1+2.85x_2$	99

Scale for y, x_1 and x_2 is the same as in the foot-note under Table 1.

TABLE 4

Input-Output Relationship for Different High Yielding Varieties of Jowar

Year and Season		*1967-68 (Irrigated or with assured rainfall)*		*1968-69 (Rainfed)*	
Soil group	*Variety*	*Relationship*	*Variation explained(%)*	*Relationship*	*Variation explained (%)*
Mixed red and black	CSH-1	$y=8.31+0.73x_1+0.59x_2$	99		
	Locals	$y=6.96+0.65x_1+0.42x_2$	99		
Medium black	CSH-1			$y=5.78+0.47x_1+1.70x_2$	95
	PJNK			$y=5.42+0.66x_1+1.64x_2$	89
Mixed red and black	CSH-1			$y=8.95+1.10x_1+0.92x_2$	99
	Improved Locals			$y=7.39+0.90x_1+0.70x_2$	97
Year and Season		*1967-68 (Irrigated or with assured rainfall)*	*Rabi*	*1968-69 (Irrigated)*	
Medium black	CSH-1	$y=28.91+1.74x_1+2.26x_2$	99	$y=43.43+1.62x_1+5.15x_2$	94
	CSH-2			$y=12.07+2.71x_1-0.38x_2-0.37x_1^2-0.29x_1x_2+0.89x_2^2$	89
	Locals	$y=22.78+0.88x_1+2.46x_2$	94		
	CO-18			$y=28.37+0.84x_1+4.16x_2$	95
	M-351			$y=12.83+3.09x_1+0.20x_2-0.54x_1^2+0.25x_1x_2-0.12x_2^2$	95

Scale for y, x_1 and x_2 is as given in the footnote under Table 1.

TABLE 5

Input-Output Relationships for Different High-Yielding Varieties of Bajra

Year		*1967-68 (Irrigated or with assured rainfall)*		*1968-69 (Irrigated)*	
Soil Group	*Variety*	*Relationship*	*Variation explained (%)*	*Relationship*	*Variation explained (%)*
(1)	(2)	(3)	(4)	(5)	(6)
Alluvial	HB-1	$y=9.52+1.34x_1+0.86x_2$	99	$y=9.61+1.47x_1+1.10x_2$	98
	Locals	$y=8.31+1.09x_1+0.72x_2$	99.7		
	H-115			$y=14.37+0.79x_1+2.35x_2$	88
	N-207			$y=13.79+0.96x_1+2.32x_2$	93
Year				1968-69 (Rainfed)	
Alluvial	H-115			$y=13.59+0.72x_1+0.84x_2$	96
	N-207			$y=10.99+0.72x_1+1.33x_2$	97
	Improved locals			$y=9.92+1.26x_1+0.85x_2$	99
Grey Brown	HB-1	*			
	Locals	*			

*In these cases even quadratic accounted for about 65 or less per cent of variation.
Scale for y, x_1 and x_2 is given in the footnote under Table 1.

TABLE 6

Average Prices of N and P_2O_5 and the Respective Inputs Output Price Ratios

Input/Output	*Price (in Rs /Q)*	*Price Ratio**	
		Px_1/Py	Px_2/Py
(1)	(2)	(3)	(4)
Inputs			
Nitrogen (N)	212	—	—
Phosphorus (P_2O_5)	184	—	—
Outputs			
*Paddy***			
TN-1	67	0.95	0.83
IR-8	59	1.08	0.94
Taichung-65	54	1.18	1.02
Wheat			
PV-18	79	0.81	0.70
Sonora-64	74	0.86	0.75
Lerma-Rojo	83	0.77	0.67
Maize			
Ganga-3	63	1.01	0.88
Ganga Safed-2	63	1.01	0.88
Jowar			
CSH-1	75	0.85	0.74
Bajra			
HB-1	71	0.90	0.78

*Scale for y, x_1 and x_2 is the same as noted in the footnote under Table 1.

**Price for Rice was converted into that of Paddy.

TABLE 7

Optimum Dosages of Fertilizer for High-Yielding Varieties of Major Cereal Crops

Crop and Season	*Soil Group*	*Variety*	*Optimum dosages of fertilizers (kg/ha)*			
			1967-1968		*1968-1969*	
			N	P_2O_5	*N*	P_2O_5
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Paddy (Kharif)	**Alluvial**	TN-1	120	60	120	60
		IR-8	—	—	120	60
		BR-34	—	—	120	60
		Jona-349	—	—	120	60
	Coastal Alluvium	IR-8	120	60	120	60
		CO-25	120	60	—	—
		ADT-27	—	—	120	60
	Red Soil	IR-8	—	—	120	60
		Taichung-65	120	60	—	—
		GEB-24	—	—	120	60
		TKM-6	—	—	120	60
	Medium Black	IR-8	120	60	120	60
		ADT-27	—	—	120	60
	Laterite	TN-1	120	60	—	—
	Black soil	IR-8	—	—	120	60
	Red and Black	IR-8	120	60	—	—
	Red and Yellow	IR-8	—	—	120	60
Paddy (Rabi) Irrigated	**Alluvial**	IR-8	—	—	120	60
		CO-25	—	—	120	60
	Coastal Alluvium	IR-8	120	60	—	—
	Red Soil	IR-8	—	—	120	60
		ADT-27	—	—	120	60
	Black Soil	IR-8	—	—	120	60
	Red and Black	IR-8	120	60	—	—
		TN-1	120	60	—	—
	Red and Yellow	IR-8	0	60	—	—
		TN-1	120	60	102	27
Paddy (Rabi) (Rainfed)	**Coastal Alluvium**	IR-8	—	—	0	60
	Red Soil	IR-8	—	—	120	60
		ADT-27	—	—	120	60
	Red and Laterite	IR-8	—	—	120	60
		CO-25	—	—	120	60
Wheat	**Alluvial**	PV-18	120	60	—	—
		Sonora-64	120	60	—	—
		S-227	—	—	120	60
		S-308	—	—	120	60
		Lerma Rojo	—	—	120	60
		C-306	—	—	120	60
		Pb-591	—	—	120	60
		NP-824	—	—	120	60

TABLE 7 *(continued)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Medium black	Lerma Rojo	33	24	—	—
		S-308	—	—	0	42
		NP-824	—	—	0	60
	Deep black	S-227	—	—	120	60
		HY-65	—	—	120	60
	Red and black	Lerma Rojo	120	60	—	—
		S-227	—	—	120	60
		K-68	—	—	120	60
	Grey brown	S-227	—	—	120	60
	Red Soil	S-227	—	—	120	60
		NP-824	—	—	120	60
Maize (Kharif) (Irrigated)	**Alluvial**	Ganga-2	—	—	120	60
		Ganga-3	120	60	120	60
		Ganga Safed-2	120	60	—	—
		Ganga-5	—	—	120	60
Maize (Kharif) (Rainfed)	**Alluvial**	Ganga-3	—	—	120	60
	Hilly Soil	Ganga-3	—	—	120	60
Maize (Rabi) (Irrigated)	**Medium black**	Ganga-3	—	—	120	60
		Deccan	—	—	120	60
Jowar Kharif) (Irrigated)	**Mixed red and black**	CSH-1	0	0	—	—
	Medium black	CSH-1	—	—	0	60
		PJNK	—	—	0	60
Jowar (Kharif) Rainfed	**Mixed red and black**	CSH-1	—	—	120	60
Jowar (Rabi) Irrigated	**Medium black**	CSH-2	—	—	108	24
		CO-18	—	—	30	60
		CSH-1	120	60	120	60
Bajra (Irrigated)	**Alluvial**	HB-1	120	60	120	60
		H-115	—	—	0	60
		N-207	—	—	120	60
Bajra (Rainfed)	**Alluvial**	H-115	—	—	0	60
		N-207	—	—	0	60

TABLE 8

Average Yield Rates with and without Fertilizer and Response/kg of Plant Nutrients of High Yielding Varieties of Major Cereal Crops*

Crop	Variety	1967-68 Irrigated or with assured rainfall Yield Q/ha			1968-69					
					Irrigated Yield Q/ha		Response/kg of plant nutrients (kg.)	Rainfed Yield Q/ha		Response/kg. of plant nutrients (kg)
		No fert.	With fert.**	Response/kg of plant nutrients (kg.)	No. fert.	With fert.		No fert.	With fert.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Paddy	I.R-8	35	50 (0.124)	8.3 (0.361)	29	48 (0.249)	10.6 (0.234)	36	52 (0.418)	8.9 (0.371)
	T.N-1	24	40 (0.311)	8.9 (0.384)	32	45 (2.024)	7.2 (0.758)	—	—	—
	Taichung-65	21	35 (1.077)	7.8 (1.820)	—	—	—	—	—	—
	C.O-25	41	57 (0.714)	8.9 (0.670)	34	56 (0.604)	12.2 (0.5[illegible]9)	43	54 (0.865)	6.1 (0.813)
	A.D.T.-27	—	—	—	36	54 (0.544)	10.0 (0.511)	37	56 (0.372)	10.6 (0.351)

TABLE 8 (*Continued*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Jona-349	—	—	—	25	42 (0.824)	9 4 (0.774)	—	—	—
	B R.-34	—	—	—	21	38 (1.508)	9.4 (0.448)	—	—	—
	M.T.U.-3	—	—	—	30	47 (0.800)	9.4 (0.745)	—	—	—
	G.E.B.-24	—	—	—	29	50 (1.439)	11.7 (1.[illegible]51)	—	—	—
	T.K.M-6	—	—	—	26	46 (0.831)	11 1 (0.780)	—	—	—
Wheat	P.V.-18	29	53 (0.106)	13 3 (0.982)	—	—	—	—	—	—
	Sonora-64	20	39 (1.046)	10 6 (0.316)	—	—	—	—	—	—
	Lerma Rojo	13	18 (0 294)	2.8 (0.336)	16	36 (0.574)	11.1 (0.539)	—	—	—
	S-227	—	—	—	22	40 (0.412)	10.0 (0.387)	—	—	—
	S-308	—	—	—	14	22 (0 276)	4.4 (0.226)	—	—	—

TABLE 8 (*continued*)

(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*
	Hy-65	—	—	—	11	38 (2.094)	15.0 (1 966)	—	—	—
	C-306	—	—	—	20	35 (0.541)	8.3 (0.508)	—	—	—
	Pb-591	—	—	—	17	32 (0 239)	8 3 (0.225)	—	—	—
	K-68	—	—	—	17	28 (0 176)	6.1 (0.499)	—	—	—
	N.P-824	—	—	—	20	27 (0.324)	3.9 (0 238)	—	—	—
Maize	Ganga Safed-2	15	28 (0.451)	7.2 (0.461)	—	—	—	—	—	—
	Ganga-2	—	—	—	15	23 (0.630)	4.4 (0.591)	—	—	—
	Ganga-3	23	37 (0.209)	7.8 (0.196)	18	33 (0.449)	8.3 (0.422)	19	29 (0.293)	5.6 (0.275)
	Ganga-5	—	—	—	28	43 (0.857)	8 3 (0.816)	—	—	—
	Deccan	—	—	—	29	46 (1.002)	9.4 (0.941)	—	—	—

TABLE 8 (*continued*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Jowar	C.S.H-1	13	37 (0.416)	13.3 (0.384)	42	59 (1.168)	9.4 (1.096)	6	10 (0.365)	2 2 (0.212)
	C.S.H-2	—	—	—	12	16 (2.341)	3.0 (1.289)	—	—	—
	C.O-18	—	—	—	28	38 (0.880)	11.1 (1 126)	—	—	—
	P.J.N.K.	—	—	—	—	—	—	5	9 (0.714)	6.7 (1.2·8)
Bajra	H.B-1	10	17 (0.246)	3.9 (0.232)	10	18 (0.272)	4.4 (0.256)	—	—	—
	H-115	—	—	—	14	19 (0.995)	8 3 (1.726)	14	15 (0.353)	1.7 (0.613)
	N-207	—	—	—	14	22 (0.609)	4.4 (0.572)	11	14 (0.202)	5.0 (0.599)

*1 kg. of plant nutrients constitutes N and P_2O_5 generally in the ratio 2 : 1 excepting a few cases such as H-115, N-207 of Bajra, C.O-18 of Jowar etc , where it comprises N and P_2O_5 in the ratio 1 : 2, 9 : 2 etc.
**Fertilizer in efficient dosage of 120 kg. N and 60 kg. P_2O_5 per ha. excepting a few cases as shown in Table 7.
N.B. Figures in the brackets denote standard errors.