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RAPPORTEUR'S REPORT

ON

ECONOMIC ASPECTS OF HIGH-YIELDING VARIETIES PROGRAMME

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The participants had been asked to direct their research efforts to :

1. Specifying the economic environment and input needs for the success of high-yielding varieties (HYV) programme at farm/regional/national level.
2. Analysing the impact of the cultivation of high-yielding varieties on cropping pattern, efficiency of resource use, farm income and investment.
3. Working out optimal allocation of farm resources as between high-yielding and local (improved) varieties of crops.
4. Outlining the organizational problems of research and extension to make the programme a dynamic venture; and
5. Evaluating the social costs and benefits of the programme with particular reference to social changes arising out of the cultivation of high-yielding varieties.

In all, the Rapporteur received 33 papers for consideration. Out of these, 11 are recommended for full reproduction and the rest for reproduction of summary only. All of them fell within the scope of the topics 1–5. However most of the papers concerned themselves with a part of topic 2 while a few directed their attention to a part of topic 3, namely, the optimal allocation of *one* farm resource, chemical fertilizer. The distribution of papers according to the crops is as follows : (two papers which included a discussion of more than one crop have been put under each of the crops they discussed) Rice: (14), Wheat (9), Bajra (5), Jowar (2), Maize (2).

The papers that are devoted to a discussion of the impact of HYV on farm income and/or optimal allocation of farm resources adopted one or the other of following two methodological approaches :

(1) Interviewing a sample of cultivators growing high-yielding and local varieties and comparing costs of and returns from the cultivation of these varieties. Twelve papers were of this type. The sampling procedure used was not always specified; some form of random sampling—simple, cluster or stratified—was used in seven cases. Alternative cost and return concepts based on those of Farm Management Surveys have been used. The input and yield data are from farmer's fields, though it is not clear whether the cultivators were subject to supervision by, and advice from, the extension agencies.

(2) Estimating the response of yields per hectare to varying dosages of chemical inputs particularly nitrogen. With the response function, generally a quadratic, thus obtained and with some assumption about the relative price of output to that of nitrogen, profit maximizing dosages of nitrogen are derived. Eight papers fall under this category. The data used are from (presumably) controlled experiments conducted at experimental stations.

Of the nine general papers, three discuss some aspects of the HYV programme in general, two are devoted (at least in their title) to risk and uncertainty associated with the cultivation of HYV, one to co-operative credit for HYV, one being a study of the development of seed industry, one to the socio-economic aspects of HYV programme, the last to a case study of the rate of adoption and causes thereof of the cultivation of hybrid maize, in a district of Andhra Pradesh.

Let me begin my discussion of the papers with some general methodological comments. First, (with some notable exceptions) most of the authors of the interview-cum-farm management school content themselves with pointing out that cultivation of high-yielding varieties provides substantially higher returns (per hectare of land) over costs. The question is not even asked much less answered, whether these returns (either from the cultivation of HYV or local variety) are in fact the maximum attainable from the resources used or alternatively whether the resource costs are minimized for the returns obtained. The closest that some come to this sort of issue is when they try to compare the actual practices of the farmers (regarding seed rates, dosages and method of application of fertilizers, pesticides, etc.,) with the 'recommended' practices. This comparison is useful only when the package of recommended practices has been derived through some resource optimizing (suitably defined) procedure. This is hardly likely to be the case since recommendations are more often than not of agronomists and plant breeders who aim at physical output maximization rather than maximization of net return over costs. To reiterate, one is not quite sure whether the figures for excess return per hectare for the HYV as compared to the local variety found in these papers represent the true excess in the sense of the difference of returns when both varieties are cultivated with a corresponding optimal combination of resources. The excess returns reported may overstate or understate the true figures depending on whether the cultivation of HYV or the local variety is carried under conditions closer to optimum. Second, these authors (again with a few exceptions) report only the average costs and returns for the set of cultivators interviewed—inter-farmer differences in performances and practices are not analysed at all. These differences are extremely useful in themselves, as well as in judging the reliability of the average reported.

Let me now turn to the response function school. As mentioned earlier this school (with one solitary exception) uses experimental data on response of yields to nitrogen application and considers the optimal use of only one input—nitrogen. One important note of caution is in order in utilizing the results of this school—cultivation of the very same variety in farmer's fields is likely to yield results different from the experimental results, firstly because the farmer either may not conform to the controlled conditions of the experiment out of lack of knowledge or may have to incur some cost in ensuring such controls which may not be negligible. Secondly, the experiments are usually conducted in very small

plots—sometimes as small as 1/2700 of a hectare and all the plots are therefore likely to be situated in a fairly small area. Thus the variance in yields observed in the experiment is likely to be much less than the variance likely to obtain in the cultivation of the same variety in farmer's fields. Thirdly, as my colleague B. S. Minhas and I are finding, the variation in performance of the same variety (high-yielding or local) between one experimental station to another in the same year, or between one year to another at the same station, and for that matter between one experiment to another at the same station for the same year are substantial enough to warrant extreme caution in the use of these results. Fourthly and lastly, most of these studies work out the optimal doses of nitrogen for alternative ratios of output price to that of nitrogen. This procedure is justifiable only if all other costs are proportional either to output or to fertilizer input; a special case of this being all other costs being invariant with respect to fertilizer use. This assumption is not probably justified and I must admit that Minhas and I are guilty of this crime in our *Yojana* paper. We made the assumption that all other costs are proportional to output.

With the general comments out of the way, let me turn to the individual papers. I have tried (but not completely successfully, since I received the papers in four batches) to discuss the papers under each crop in one group. Within each crop, I have not tried to keep any order.

M. K. Shingarey and R. E. Waghmare randomly sampled 40 cultivators from 16 villages of Kolaba district of Maharashtra. The villages were selected because of their having 'large' area under Taichung Native I, a rice variety. Data from seven farmers were rejected because they were incomplete. The farm management type analysis showed that cultivation of T. N. I. yielded about 6 quintals per acre more grain and about Rs. 62 per acre additional net gain over the local variety grown by the same farmers. These gains were of the order of 33 per cent extra grain and 27 per cent of extra income over local variety and are not particularly impressive. The authors also estimate a Cobb-Douglas type production function relating yield of T. N. I. to land, human labour, bullock labour and working capital excluding expenditure on human and bullock labour. Only land and bullock labour had elasticities significantly different from zero. The authors could have re-estimated the significant coefficients after omitting the insignificant ones but have not. Without testing whether the sum of the elasticities is significantly different from unity, they assert that the production function exhibits increasing returns to scale!

T. Ramakrishna Rao studies the performance of the rice variety I.R.-8 in the West Godavari district. Unfortunately, his study lacks in objectivity for the reason that he has chosen his sample villages and sample blocks that were 'good' as far as coverage and performance of I.R.-8 are concerned. From each of the four selected villages, 18 participants and 7 non-participants were contacted. The participants were younger and more educated than the non-participants. The differences between the participants and non-participants with respect to yields of and net income from cultivation of local variety are not notable. The variety I.R.-8 on an average yielded about 58 per cent more grain per acre (23 quintals *versus* 14.6 quintals) and about 22 per cent more net income (Rs. 901 *versus* Rs. 737). The author notes that small cultivators (holding less than 10 acres)

devoted greater area (35 per cent) to I.R.-8 than large cultivators (20 per cent). This fact perhaps contributes to the result that the expenditure on hired labour per acre is not very much higher for I.R.-8 than for local variety. It is conceivable that the small farmers contribute quite a bit of family labour to cultivation.

M.D. Gopalakrishnan studies the performance of ADT-27 in the Thanjavur district. He contacted 50 cultivators from two villages of a "progressive" block in the district. The method of selection is not specified. He documents the rapid spread of the cultivation of this short maturing, high-yielding variety in the course of just 3 years, from 4,800 acres in 1965-66 to 448,000 acres in 1967-68. Even in 1966-67, the worst year regarding weather, ADT-27 yielded 30 per cent more than the local variety. The gross income (net of cash expenditure) was on an average higher by 45 per cent (Rs. 547 per acre *versus* Rs. 377) over the local variety among the cultivators of his sample. The shorter duration of ADT-27 has also enabled double cropping in a large portion of traditionally single cropped land.

P. N. Das obtains his yield data from randomly selected plots (80 in all) growing one or other of the high-yielding varieties of paddy—unfortunately, he does not distinguish between one HYV and another—this is extremely unfortunate since all the HYV's do not perform equally well. His main finding may be summarized as : the HYV yielded on an average 24.20 quintals per acre of paddy while the improved and ordinary local varieties yielded 9.36 and 5.36 quintals per acre respectively. The corresponding net income (and total costs) per acre are respectively Rs. 912.29 (Rs. 404.84), Rs. 307.03 (Rs. 202.42) and Rs. 89.30 (Rs. 202.42). I wonder whether it is mere coincidence that the cost per acre for HYV is exactly double that for the local variety. Be that as it may, the most curious conclusion of Das is his statement "notwithstanding the relative economic efficiency of HYV, the cost per acre is higher than per capita State income (Rs. 278) by 46 per cent. This is a basic constraint at farm level which has to be neutralised by large scale State subsidy method....." It is beyond me why per capita State income is being compared with cost per acre. Has the author assumed that each family has an acre per capita? Even so why should such a comparison be relevant? Probably, the author meant to say that State credit rather than subsidy should be provided for enabling the farmers to cultivate the HYV. After all, the net income per acre even after providing for family labour is Rs. 912.29 according to Das!

The paper by I. J. Singh, T. K. Chowdhury and Dinkar Rao belongs to the response function school and concerns itself only with three HYV—I.R.-8, Tainan-3 and China-4. No local variety is considered for comparison. It is found that given the price of paddy at Rs. 68 per quintal and nitrogen at Rs. 184 per quintal, nitrogen when applied in optimal doses yields an extra income of Rs. 730 per hectare in the case of I.R.-8 and Rs. 602 and Rs. 167 respectively in the cases of Tainan-3 and China-4.

Parikshit Roy sent questionnaires not only to farmers but to Block Development and Agricultural Extension Officers as well. The questions asked are on the whole not particularly imaginative and not surprisingly the answers from all the three groups are broadly similar except for one question. When asked whether

levy of paddy for procurement purposes is hindering the extension of HYV, farmers were more rational than the Block Development Officers and Agricultural Extension Officers in their answers. Eighty-one per cent of farmers replied 'No' while the corresponding percentage was 61 and 58 respectively for Block Development Officers and Agricultural Extension Officers. Roy reproduces the estimates of average cost (in six districts for the year 1967-68) of cultivation of traditional and HYV collected by Agriculture and Community Development (?) Department of West Bengal Government. It turns out that net incomes per acre were Rs. 569 for local variety and Rs. 549 and Rs. 1,009 respectively for the high-yielding varieties depending on whether one considered the farm management study or the national demonstration. In the national demonstrations, the yield rate was 53.53 maunds per acre while in farm management studies the yield rate was only 34.46 maunds. Apparently, the lower yield is due to inadequate fertilizer and plant protection inputs as is evident from a comparison of expenditure on these items. These comparisons bring home my general remarks that the excess returns as obtained from farm management or even national demonstration data can be misleading if the cultivation practices adopted are non-optimal.

D. Gohain does not reveal how his sample of 100 farmers was selected and as such it is difficult to interpret his interesting attempt to study the proportion of total area devoted to HYV and local variety as well as physical and financial return from the cultivation of the two varieties according to size of land holding. Barring the size-group less than an acre which was represented just by one farmer in his sample, it would appear that (taking both seasons together) the size-group 2.50—5 acres devoted the largest proportion (about 30 per cent) and got the highest yield (about 19 quintals (?) per acre) from HYV. There are no notable differences either in the area devoted to or yield from HYV among the other four size-groups (5—7.50, 7.50—10.00, 10.00—15.00 and above 15 acres). Gohain complains that the farmers did not use the recommended dosages of fertilizers and pesticides because of their 'high' price. May be the farmers are using the dosages that will maximize their net return given the prices of inputs and output and may be the recommended dosages are irrelevant from an economic point of view.

B. K. Chowdhury and M. G. Ghosh have studied a random sample of 100 farmers, 60 of whom participated in HYV programme and the rest had not. They also provide data regarding participation in the programme among all farmers in the four villages studied by them. Though the authors claim that participation (in terms of proportion of area devoted to HYV) shows a distinct trend of increase with the increase in farm size, I am not convinced that this apparent increase is significant statistically if one takes into account the fact that large farms (less then 10 acres) are considerably fewer in number than those in the size-groups less than 5 acres and 5—10 acres. In the case of participant farms, only two HYV, I.R.-8 and N.C. 678 (accounting for more than 50 per cent of the area devoted to HYV) had yields greater than the local variety. The authors suggest, though they do not document these facts, that late sowing, over-aged seedlings and inadequate fertilizer inputs may have been responsible for the bad performance of some of the HYV. The clubbing together of all the HYV in comparing returns over costs for HYV and local varieties has resulted in the better showing of ordinary varieties. The authors are however careful to point out that the best HYV of their

sample, namely, I.R.-8, yields a profit of Rs. 520 per acre as compared to a figure of Rs. 372 for the local variety.

Narottam Nanda's paper is noted for two things—firstly for his liberal quotations from other publications almost every other sentence and secondly from its consideration of an important question—the influence on yield of repeated cultivation from the same field, the method of seed selection, etc. Unfortunately, his sample consists of only three cultivators and the weather gods have also played havoc with the experiment. As such his data are hardly reliable. He certainly deserves an A for effort!

Let me now turn to the papers on wheat. Harpal Singh fits quadratic response functions to data from uniform high fertility trials during 1966-67 and obtains the optimum doses of nitrogen to be applied for alternative wheat/nitrogen price ratios. He has pooled the data from stations in Punjab, Haryana and Delhi into one group and the stations in Uttar Pradesh, Rajasthan, and Bihar into a group each. As I mentioned earlier, differences in response between stations are very often statistically significant so as to rule out any pooling. As such conclusions from pooled data have to be used with caution. Harpal Singh's mechanical application of the optimizing procedure leads him to recommend negative amounts of nitrogen to be applied to the variety Lerma Rojo in Madhya Pradesh for all price ratios ranging between 2.5—5.0! This absurdity arises from the fact that even at a zero level of nitrogen, the marginal response of 2.44 is below the price ratios (2.5—5.00). Hence, given diminishing marginal response, Harpal Singh has to take nitrogen off the soil to get to marginal responses lying in the range 2.5—5.00! He does not mention the levels at which basal doses of potash and phosphorus were applied. In so far as the effects of different fertilizers used are not additive, the optimal dosages of nitrogen calculated by him will correspond to the particular doses of other fertilizers applied.

J. P. Dubey, Y. M. Upadhyaya and S. P. Kohli use presumably similar data. They do mention the basal doses of 60 kgs./ha. of phosphate and 40 kgs./ha. of potash. They note the wide variations in responses at different stations but have nevertheless pooled them all for presenting all-India response function. Curiously enough, they have tried a cubic ($a + bx + cx^2 + dx^3$) response to mean yields obtained from just 4 levels—0, 60, 120 and 180 kgs./ha. Even without trying, one could have predicted their result—the function fits exactly—after all with 4 parameters (a, b, c, d) to be estimated from 4 observations, what else could happen! Any way, mercifully they are presenting only quadratic response functions. The note of caution in using pooled response data is even stronger in the case of all-India pooling of Dubey, *et. al.*, than in the case of State pooling of Harpal Singh.

The paper of A. S. Kahlon and J. L. Kaul is very useful in that they consider the response with respect to nitrogen, phosphorus and potash at the same time. I assume that potash did not contribute significantly to yield and hence has been omitted from their analysis. In the case of two (C 306 and Kalyan 227) of the three varieties considered, the interaction between nitrogen and phosphorus was positive and significant. The extra profits obtainable by using nitrogen and phosphorus with the variety K 227 varied from Rs. 3,290 per hectare to Rs. 4,054

per hectare depending on whether wheat price was Rs. 70 or Rs. 85 per quintal. The profits from the local tall variety C 306 was about 30 per cent lower. The authors point out also that at a price of Rs. 80 per quintal for wheat and Rs. 151.52 and Rs. 131.25 for a quintal of N and P respectively, the demand for fertilizers will exceed the supply even if one assumed that only 60 per cent of the wheat area in Punjab is devoted to the cultivation of the dwarf variety K 227. Thus if the fertilizer supplies are not changed, market clearance is possible only if either wheat price is lowered or fertilizer price increased.

I. J. Singh and K. C. Sharma analyse the experimental data for the three years 1965-67 for the response of HYV and local varieties to nitrogen. Six levels of nitrogen (0, 40, 80, 120, 160 and 200 kgs. per hectare) were tried. Eighty kilograms of phosphorus and potash were added to all levels of nitrogen. It appears that they have fitted a quadratic response function to mean yields of all the three years put together. At the risk of sounding tiresome let me repeat that (*a*) this pooling is valid only if the individual year response functions are not significantly different from each other and (*b*) the possibility of interaction between phosphorus, potash and nitrogen must not be ignored. With these qualifications in mind, let me bring to your notice one interesting conclusion of theirs—the profit maximizing dosages of nitrogen (given the price of wheat at Rs. 76 per quintal for the dwarf wheat and Rs. 265 per quintal for nitrogen) are closer to (in some cases less than) the minimum recommended by agronomists. This corroborates my earlier remark that agronomists are probably maximizing output rather than profits.

T. K. Chowdhury, Bhagwati Prasad, K. K. Bhatia and J. R. Arora present cost and returns data for different varieties of wheat for the year 1967-68 obtained from the farmers in the Tarai region of Nainital district. Excepting the varieties S 227, S 308 which were grown for seed multiplication and fetched prices of Rs. 2,000 and Rs. 500 per quintal respectively, the other high-yielding varieties S 64, Lerma Rojo grown commercially yielded just about the same return per acre (about Rs. 330) as the local variety C 273.

G. S. Lavania and R. S. Dixit used cluster sampling to select their first stage units, namely, villages. In all, three villages were chosen. Farms from the villages growing both high-yielding and local varieties were arranged in three size-groups (greater than 2 hectares, 2 to 4 hectares and more than 4 hectares) and 33 per cent of farms from each size-group were chosen by random. Besides wheat, they considered maize and bajra as well. The farms under the second size-group devoted only 37 per cent of their cropped area to the three crops considered while the first and the third devoted respectively 66 per cent and 53 per cent. There is no conclusive evidence in their study to suggest that small farmers are likely to devote less area to HYV. The small farms come out the best with respect to high-yielding maize and bajra. In terms of net income per hectare (using the most comprehensive concept of cost), the first size-group comes out best only with respect to local wheat and local bajra while the third size-group leads others in respect of high-yielding wheat, maize and bajra. The variation in per hectare net income between crops for each size-group is quite high. For instance, in the case of size-group 1, growing local maize yields an income of Rs. 102 per hectare while high-yielding wheat yields Rs. 883. In all cases, high-yielding varieties give higher income. Unfortunately, the authors have not indicated which

high-yielding varieties were used and the cost of inputs that were associated with the cultivation of each. Given the variation in the performance of different varieties, one has to be careful in interpreting their results.

J. S. Sisodia focusses his attention on Ninod village of Indore district. He sampled 15 farm families each from those who are and those who are not, participating in the HYV programme. The average operational holding of participant farms was 9.72 hectares of which 1.24 hectares were irrigated. The corresponding figures for non-participant farms were 7.22 hectares and 0.24 hectare. Though this may indicate that participation may be related to size of holding and irrigation facilities, one must look at the figures for the individual farms within the participant group to see whether there is any association between these two variables and the participation rate measured by area under HYV. Sisodia's data reveal that the difference in performance (either in terms of physical yield or income) between participants and non-participants is not very much in the case of local wheats. The best high-yielding variety S 227 yielded more than five times the output of local variety in the case of participant farms. The same high-yielding variety yielded seven times as much income as the local variety (Rs. 2,324 as compared to Rs. 324.)

D. K. Desai and D. A. Patel attempt to estimate the demand for hybrid bajra seed in the Amreli district of Gujarat. Demand is interpreted in two ways: (*a*) as a point estimate of the expected purchase of seed in *Khariff* 1968 and (*b*) as a demand function, *i.e.*, quantity of seed demanded as a function of its price. Two sets of demand estimates and demand functions are obtained from (*a*) a questionnaire distributed to Village Level Workers (VLW) from 15 randomly (with probability proportional to the area under bajra) selected VLW circles out of a total of 84 such circles and (*b*) a random sample of 150 farmers, selected at the rate of 10 farmers from each randomly chosen village in each of 15 VLW circles selected for (*a*). These ten farmers in each village were selected, randomly, at the rate of two from each of five equal groups (equal in the sense of equal operated area) into which all farmers in the village were classified (after listing them in ascending order of size of operated holding).

Though the authors do not seem to have observed, it appears that the differences in estimated demand for hybrid bajra seed and area devoted to cultivation of it as obtained by the VLW and farmers' surveys are not significantly different. I reach this conclusion from the fact that the estimate of either survey for demand and area falls within the 95 per cent confidence interval for the same item from the other survey. Only in respect of the number of farmers likely to adopt the cultivation of the new variety do the two surveys seem to differ significantly and in this respect probably the farmers know their minds better than the VLW's!

The authors attempt to relate the demand for seed with factors likely to be related to it, through linear and double-log regression. Unfortunately, they have excluded two variables in each regression simply on the ground that each had a low zero order correlation with the dependent variable. This is a very dubious statistical procedure, and I am not, therefore, commenting on their findings from such regression.

One of the most interesting aspects of their paper is the attempt to derive the demand function for seed by asking farmers how much seed they would buy at each stipulated price. They find the demand to be highly price elastic, a surprising result indeed, as the authors themselves have noted if one were to assume that seed rates per acre were constant. There is no reason to assume this. It may be, that seed rates are variable within a range and beyond this range output drops rapidly. In such a case the result obtained by the authors is conceivable. They relate the quantity of seed demanded per *farm* and not per *acre* to its price and this is not very a meaningful procedure if the farm vary very much in size.

R. S. Savale sampled 66 cultivators from seven villages in the Dhulia district of Maharashtra. Unfortunately, he does not indicate the number selected from each village. Though he provides data on the age composition, educational background and size of holding of the 66 farmers, he does not attempt to relate these to the extent of cultivation of high-yielding variety of bajra. His main findings are that (*a*) the yield per acre of HYV varied from 426 kgs. to 887 kgs. in the seven villages while the best yield during the period 1951-60 in the Dhulia district was only 217 kgs. The net income per acre from cultivation of high-yielding variety of bajra varied from Rs. 76 to Rs. 470.

K. K. S. Chauhan and N. L. Agarwal report on the demonstrations laid out in the fields of ten randomly selected farmers, one from each of ten villages of the Panchayat Samitis of Samber-lake and Dudu in the Jaipur district. They find that on an average hybrid bajra yielded Rs. 319 per acre (returns to fixed farm resources) as compared to Rs. 195 for local bajra. The range of variation among the ten farmers was Rs. 145—Rs. 1,509 in the case of hybrid and Rs. 138 to Rs. 388 in the case of local variety. They give no other information and it is difficult to examine the sources of such high variation. They also tabulate what they call marginal cost and marginal return—these are simply the differences *for each farmer* between the averages (per acre) of return and cost of hybrid and local varieties—a curious notion of margin indeed!

J. V. Venkataram and R. Ramanna are the authors of a paper on jowar. They present the average costs and return of 15 randomly selected farmers from three villages of Dharwar taluk, five from each village. It turns out that the hybrid yields more than twice the output per acre than the local jowar (11.55 quintals *versus* 4.20 quintals). In terms of net returns per acre, hybrid yielded Rs. 545 as compared to Rs. 229 for the local.

Amiyamoy Chatterjee's critique of the HYV programme is a very curious one. In what he calls 'background of agriculture in India' he reproduces published data to show that less than 30 per cent of the 158 districts of India (producing at least 0.1 per cent of total production of paddy) accounted for more than 50 per cent of total production. The relevance of this to HYV programme escapes me. At any rate, districts vary greatly in cultivable area and it is not clear that concentration of output in a few districts has any significance. The yield per hectare data, he reproduces, indeed suggests that the districts that accounted for a large part of production are not noted for their high yields. His discussion of HYV, other than suggesting trivially that HYV will be economic if it reduces the average cost of production below that of the local variety, has no data or interesting insights to offer.

R. R. Pradhan's paper on some aspects of high-yielding varieties reads more like an official publication, listing targets, a few facts and a lot of platitudes. Not much of hard data or critical and incisive comments are found in this paper.

M. Srinivasan's paper, in the main, is like Pradhan's though it contains more official targets together with likely achievements. The last section of the paper purports to be a case study of 12 farmers, each growing high-yielding and local varieties of paddy and jowar. The method of selection of these farmers is not specified. And, it is not at all clear from the paper whether the costs, yields, etc., reported are averages of actual performance or they are merely planned cost and expected return. I suspect they are the latter.

B. Das's paper deals with the resource productivity of farms in the Sambalpur district of Orissa. He fits a Cobb-Douglas type production function to data on yield, human labour, bullock labour, plant protection expenditure, and expenditure on manures and fertilizers. These relate to some 50 one-acre demonstration plots growing one or other of more than five high-yielding varieties and 16 plots growing some local improved variety or other. Some of his elasticities are negative and others exceed unity, the former indicating that the marginal productivity of such an input is negative at all levels and the latter indicating increasing marginal product for these inputs. Neither of these results is plausible. I suspect that these troubles arise because he has pooled the data relating to different varieties which have different performance characteristics.

S. R. Subramanian uses exactly the same data on ADT–27 (from Tanjore district) as Gopalakrishnan and fits a Cobb-Douglas type production function. He, like B. Das, gets negative elasticities for some inputs, though these are not significantly different from zero. Fortunately, he has reproduced the correlation matrix of the variables used. None of the correlations among the explanatory variables is less than 0.93! After observing such high multicollinearity, it is indeed amazing that the author went ahead and estimated the regression coefficients!

There are two papers on risk and uncertainty. The first by H. K. Dasgupta provides average yield data on some new varieties of paddy together with rainfall data. No analysis is presented to show either for or against the hypothesis that the HYV are susceptible to greater risk however defined. The paper by Gurbachan Singh and T. R. Gupta lists various elements of risk and uncertainty—no data or analysis are presented and hence no conclusions can be drawn about the riskiness of high-yielding varieties.

R. K. Patel, A. S. Sirohi and B. M. Sharma fit a Cobb-Douglas type production function to the data on gross value of output of hybrid bajra, the rupee cost of inputs like human labour, bullock labour, seed and the amount of land in acres. Suppose one assumes a constant returns to scale production function relating output and all the above inputs in physical units. Then it is obvious that given the fact that all the farms are from Delhi and hence the prices of output and inputs faced by farmers are likely to be the same, the ratio of value of each input to that of output will be the same across farms except for random errors. Hence the multicollinearity observed by them is not surprising. The fact that

they found that bullock labour and human labour per acre were correlated may express nothing more than the simple fact that behind each pair of bullocks is a human being! In any case, I believe that the methodology of their paper is faulty.

Bhagwati Prasad and J. R. Arora have submitted the only paper on credit for HYV programme. Unfortunately, the paper has no analytical core—it merely compares targets with achievement in respect of area covered and credit provided in the Nainital district of Uttar Pradesh. No examination of the targets for credit is attempted.

The paper by P. R. Chetty is a long winded reproduction of some data on national demonstrations on HYV. It contributes very little by way of analysis.

Krishna Kisore Das, D. R. Sarkar and S. K. Mukhopadhyay in their paper with the misleading title—'A study on the effectiveness of results of demonstration as an extension method....' do not engage in any such study—all they report on a demonstration is that the high-yielding and improved local varieties had higher yields than the ordinary local variety. There is nothing in their paper to suggest that this demonstration was effective in converting farmers to high-yielding varieties!

The paper by D. Ramesh is of the old fashioned blah-blah type economics—all words and no quantitative or analytical focus. It also contains amazing statements. He suggests that the best way to prevent consumers from exercising their choice is not to offer them any choice!

P. V. Krishna's paper on the adoption of hybrid maize could have been a very illuminating study but is not. He interviewed 544 cultivators selected through systematic sampling. He classifies them into two groups—ever adopters, that is, those who have adopted hybrid maize at least once in the past ten years and non-adopters, those who never cultivated hybrid maize. Unfortunately, this grouping puts under the category of ever adopters, those who have been cultivating hybrid maize all along, those who have only recently taken it up and more importantly those who once adopted and then give it up. It would have been far more illuminating to have analysed these categories separately, especially the last group—one could have brought out the causes of their giving up hybrid maize after trying it. Since the crucial dependent variable, the percentage of 'ever adopters' in a village is a bad indicator of what he is trying to measure, I do not attach very much significance to his rank correlation analysis of this variable with others.

Let me now turn to the issues that can be fruitfully taken up for discussion in this session.

(1) The approach to the Fourth Five-Year Plan postulates an annual growth rate of 5 per cent for the agricultural sector as a whole. Is this a feasible target, taking into account that the HYV programme is mostly for cereals ?

(2) Almost all the papers whether of the response function school or of the farm management school, (especially the former,) come to the conclusion that

the HYV's raise yields compared to the local varieties with or without fertilizer inputs. Further at the range of prevailing prices for output and fertilizer input, if the farmers use inputs to maximize their net income per hectare, there is likely to be an excess demand for fertilizers. Given the supplies from domestic sources and planned imports, is there room for a re-examination of the price policies for fertilizers and/or output?

(3) Speaking of additional income from the cultivation of high-yielding varieties, a number of questions can be raised and need to be answered if we are to view this programme in a broader social context :

(*a*) Does the cultivation of HYV depend on the availability of irrigation and/or assured rainfall to the extent that the official pronouncements in this regard suggest? If indeed this is so, how best should the resulting disparities in income generated between region and region be tackled?

(*b*) In so far as the success of the HYV programme depends on the ready and adequate availability of credit, access to know-how, markets, etc., and in so far as these are positively related to size of holding, the HYV may benefit richer farmers to a greater extent than the poorer ones. If indeed this is true, what is the best instrument of policy in this respect?

(*c*) There is some evidence in the papers presented to suggest that the HYV programme may be a land-saving and labour using form of technical change. If this is true, one may expect an upward shift in the demand curve for agricultural labour and this may increase the wages of agricultural labourers. Even if this is a mere speculation at this moment, it may be worth discussing.

(*d*) Suppose one were to take the view that production (*i.e.*, income generation) aspect should be separated from that of income distribution. Then efficiency in production should not be sacrificed for achieving distributive objectives and the latter should be tackled through suitable fiscal means. In the present context, holders of this view will have to think up an appropriate way of taxing the beneficiaries of HYV programme to redress the disparities, if any, that might arise. This aspect may be usefully discussed.

(4) Even if output and input prices were to be uniform all over the country, it is quite clear from experimental as well as other evidence that the performance of high-yielding varieties varies widely from station to station. Does a standard set of recommendations as to dosage of fertilizers for each variety make any sense?

(5) As a supplementary to question (1) above, one may ask : if substantial *per hectare yield* growth is possible and feasible with respect to cereals because of the HYV, and such potentialities do not exist for other crops, then achieving the growth target for the agricultural sector as a whole may require some shift of area from cereals to other crops. What is the extent of the change in relative prices that will be required to bring about such a shift ?

(6) Alternatively, should the agricultural policy be to specialise in the production of cereals, export these and import other agricultural commodities to the extent needed?

(7) Unfortunately, too little attention has been paid to the risk and uncertainty aspect of cultivation of the HYV with heavy doses of chemical inputs. A systematic examination of the often asserted statement that high fertilization increases average yield at the cost of increasing the variability is required. I may add that some work in progress at my outfit by my colleague Minhas and myself suggests that the above statement is somewhat of a myth.

(8) Virtually no attention has been paid by the authors of papers to issues such as credit requirements, storage facilities, transportation and marketing facilities, etc., that will be needed to push ahead with the HYV programme. Some of the high-yielding varieties are also short-maturing. While this raises the possibility of an additional crop from the same land, it also upsets the old pattern of agricultural activity. For instance, the variety of paddy that has been gaining ground in Madras, namely, ADT-27 matures early and the harvesting time overlaps the north-east monsoon. This has resulted in problems of drying and warehousing of output.

(9) Virtually none of the authors have asked whether the new varieties can equally well withstand attacks of pests as the local ones. If not and if plant protection measures are needed to a greater extent, what is the best form of achieving such protection? There may be economies of scale in this business. Should the pest control measures such as spraying be done individually, co-operatively or under State auspices through (say) aerial spraying ?

(10) Lastly, let me mention one aspect of data collection that needs attention. If I am not mistaken, the official agent recording areas under different crops does not (and possibly cannot) record separately the area under the high-yielding varieties of each crop. Presumably the official data on the area under HYV are based on indirect evidence such as seed absorption. To say the least, this is a bit unsatisfactory. We may profitably devote some time to explore better methods of data collection, at least for evaluating the success of HYV. While I am at it, let me also mention one source of data that none of the authors have looked into, namely, the reports of the Programme Evaluation Organisation of Planning Commission on the HYV programme.