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NOTES

INDEX NUMBERS OF AGRICULTURAL PRODUCTION— FURTHER COMMENT

To restate the issues involved in the preparation of unbiased index number of agricultural production[1] (in fact crop production), the factors to contend with in the Indian context are (i) extension of coverage, and (ii) change in the method of estimating yields of crops per acre. The problem of extension of coverage becomes complicated only if the trend in the yields per acre is different from that obtaining for the 'old' coverage. We do not believe that in so far as the extension to the erstwhile Indian States or permanently settled areas are concerned the yield rate in these areas would be different from that in the 'old' reporting areas. Only when the coverage is extended to areas where marginal lands are brought under cultivation the yield rates may be different. Such lands would, however, be small and their influence on the aggregate yield trend insignificant.

Regarding the change in the method of estimating yield is concerned, again the error due to bias in the traditional method can be divided into two components (*i*) error due to constant bias and (*ii*) error due to changing bias in the traditional method. Dr. C. H. Shah is right, according to us, when he assumes that the bias in the traditional method would be changing, *i.e.*, there might be a tendency to over-estimate the yield in the poorer years and under-estimate it in the good years.[2] Calculations made by Dr. Panse few years back indicated that at the all-India level there was an overall under-estimation of about 8 per cent in the yield of cereals by the traditional method. However, we should think that, the method adopted by us should be able to adjust for the first component at least, *i.e.*, error due to constant bias. For the changing bias, a continuing comparison between the two methods of estimation of yield would be very useful, but we doubt if data for recent years would be available for the purpose. We found that crop-cutting results rapidly influenced the estimates obtained by the traditional method, even when the former was not officially accepted as the basis for yield estimation and thus an independent comparison between the two methods was hardly possible.

We feel, for the above reasons, that our method gives us the best estimate, if not totally free from bias, and the trend given based on adjusted production data is definitely more reliable and more accurate than one based on unadjusted production data. This can be seen from the various tables in our paper. Both the adjustment factors, *viz.*, extension of coverage and the changeover to crop-cutting method of yield estimation would affect the production figures in the same direction, *i.e.*, inflating the recent figures as compared to earlier figures. This has been largely corrected by the method of adjustment adopted by us. The comparison of the adjusted and unadjusted figures given in our tables shows that the adjusted production values are generally larger than corresponding unadjusted values for the earlier years and the difference which was wide for earlier years later narrowed down and finally disappeared. A more detailed analysis

1. *Vide* "Index Numbers of Agricultural Production in India," V.G. Panse and V. S. Menon, *The Indian Journal of Agricultural Economics*, Vol. XVI, No. 2, April-June, 1961, pp. 18-36.

2. *Vide* "Index Numbers of Agricultural Production—Some Methodological Considerations," *The Indian Journal of Agricultural Economics*, Vol. XVI, No. 3. July-September, 1961, pp. 17-24.

of the problem for further refinement would of course be desirable by studying separately the effects of change in coverage and change in method of estimation of yields in areas reporting for earlier years and separately in areas which have become reporting more recently. This study can also be extended to individual states and to individual districts within states. This however is the question of availability of facilities.

We would conclude that once again the adjustment of production data carried out by us is a definite improvement, though there can still be further scope for refinement. Dr. Shah's paper does not, however, contain any concrete suggestion for a further development of study on this problem.

V. G. PANSE*
and
V. S. MENON**

STATISTICAL MEASUREMENT OF VARIANCES FOR MARGINAL PHYSICAL PRODUCT AND MARGINAL RATE OF SUBSTITUTION

In production function studies the measurement of variances can be an aid in predicting the input combinations resulting in profit-maximizing and cost-minimizing. The usefulness of production function analysis lies in marginal product estimates, the variances of which are, more or less, cumbersome to estimate. The variances of marginal physical products thus derived are used for setting confidence limits and carrying out tests of significance.

The sampling variability, that is so characteristic in experimental data, seems to be a hindrance in the application of predicted optima to actual farm situations. In order to remedy this, the number of controlled variables included in the experiments can be increased, or probability estimates can be placed on uncontrolled variables. Even when this is done the predictions made in terms of point estimates are not truly reliable.

Interval estimates or confidence limits can be used to improve the measure of reliability. Confidence limits indicate a range of values within which the expected or average value of an estimate may lie, given some probability level, and are based upon the variance of the prediction.

Variance Estimates for Marginal Physical Products

The regression equation or production function to be used is :

$$\hat{Y} = aX_1 - bX_1^2 + cX_2 - dX_2^2 + eX_1X_2 \quad \ldots \quad (1)$$

where $\hat{Y}$ is the predicted yield of a crop measured in maunds per acre and X_1 and X_2 are the pounds of inputs (say fertilizer) applied per acre.

* Institute of Agricultural Research Statistics (I.C.A.R.), New Delhi.
** Ministry of Food and Agriculture, Government of India, New Delhi.