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Improving Crop Estimation to Combat the Food Crisis*

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To combat the Food Crisis in the country, planning for production to the needs of its several regions has to be undertaken. Precise statistics of home supplies in this regard are a fundamental requirement. Past agricultural crises, in this and in other countries of the world have been the result of the paucity of agricultural statistics of production and requirement. Present position, in this line, made no appreciable improvement to warrant the avoidance of such crises, in the future. Since the period required for production in agriculture is longer than in other industries, farming is extremely sensitive and gets into a crisis sooner than other industries.

Crop Statistics of the Past Thirty Years. The subject of crop forecasts and crop estimation engaged the attention of the Board of Agriculture in India, for the first time in the year 1919 and later in 1924 and 1937. Estimation of production is based on three factors, viz., area, normal yield and seasonal factor. The main defect in the procedure thus adopted is the subjective element of the personnel operating under each of the factors mentioned above. In a great many areas only rough estimates are available for the areas under various crops. But even this degree of reliability does not obtain in the case of the normal yield and seasonal factor. The normal yield, a vague and indefinite term, is in use both in America and in this country and is understood as the average yield of a crop for a specific geographical unit relating to a number of years. The seasonal factor for a year in America is expressed as a percentage of the normal yield ; in England as a percentage of the average yield of the decennium preceding. In the Province of Madras, the normal yields were fixed by Mr. Stuart in the year 1919. The seasonal factor is worked out by the Board of Revenue, from the information furnished by the tahsildars. Based on these figures, districts are declared surplus or deficit, with respect to particular commodities. It may thus be seen what a great part personal bias plays, in forecasts and in estimations of yields. Methods to make the procedure fairly objective and the estimations more reliable are indicated below.

Forecasts for Industry and Trade and Estimation for Administration. Forecasts of yield and production much in advance of the actual harvest of a crop are required by the Industry and Trade ; and estimation after harvest by the Administration, for purpose of taxation, limiting exports

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and imports and for effecting distribution, for the needs of consumers in the Province. In America, in addition to the Agricultural Department, there are various independent organisations that are engaged in crop forecasting. These organisations are conversant with the bullish and the bearish markets of the world and their forecasts, with the interest in the country's Industry and Trade, are not expected to exhibit full freedom from bias. In such forecasting, Java alone, amidst the countries of the world has attained a high degree of objectivity, in regard to the sugarcane crop. With a mass of meteorological data and crop growth figures extending over several years, mathematical functions involving these data are worked out and fairly precise forecasts of cane tonnage and sugar returns are made in advance of the harvest. This is a line in which this Province has to go ahead, to improve forecasting of crop yields.

Crop-Cutting Experiments and the Stratified Random Sample Survey. To get at the yield per unit area of a tract and thereby estimate production, crop-cutting experiments can claim a high measure of objectivity; and amongst sampling methods for the distribution of the experiments and arriving at the average yields of crops for tracts, the stratified random sample survey has come to stay in the United Kingdom and America. It is utilised to assess the incidence of pests and diseases, to know the spread of agricultural improvements, in the solution of various social, industrial and economic problems and in enquiries relating to populations, cattle census and so forth.

Cost of enumeration is no consideration in the collection of Vital Statistics which are all-important and essential for the Administration. If the cost of the enquiry is limited, valid estimates within specific ranges of error may be made by employing the stratified random sample survey. This may be likened to a complex field experiment, under split-plot design. If the census of a city is to be estimated within limits of say $\pm$ 5 per cent, the enumeration in the several strata into which the city can be split up, as wards, streets and houses may be limited. With some exploratory work, a mathematical function may be built up, by which the number of wards to be enumerated in the city and the number of streets in each ward that gets selected; and the number of houses in each of the streets that get selected, to get within the 5% limit, are known. After knowing the strengths in each stratum, the particular numbers of the wards in the city, streets within wards and houses within streets are selected from Tippett's Random Numbers of one, two, three, or four-digit tables, according as the strength of the wards, streets and houses to be enumerated, lies within one, two, three, or four-digit figures. Professor Mahalanobis derived functions bringing out the relationship between size of sampling unit, distribution and variance between the samples. Dr. Panse applied a similar method in 1942–43, in estimating the yield of cotton in Akola District, in the Central Provinces.

Crop-Cutting Survey on Paddy in the Madras Province, 1945—48. Dr. Sukhatme, employed, for certain exploratory studies carried out in the Tanjore delta during 1944—45, the function :—

$$V(\bar{x}) = \frac{V}{m} + \frac{F}{mf}, \text{ where}$$

$V(\bar{x})$ is the sampling variance of the estimated average yield,
V is the estimated true variance between villages within taluks,
F is the true variance between fields within villages,
m is the total number of villages selected for the experiment and distributed in proportion to the area under paddy in the different taluks and
f is the number of fields selected for the experiment, in each selected village.

For crop-cutting experiments on paddy under the stratified random sample survey, the district, the taluk, the village, the survey number and the field ('thalai') are the several strata, on the analogy of the ward, street and house, in the example of the city referred to previously. Ninetyeight per cent of the paddy crop in the province, is contained in seventeen districts. To give the estimate of yield with a standard error of five per cent, four to eight villages per taluk, depending on the area and the number of paddy crops raised in it in one year, three survey numbers per village and a plot in one 'thalai' of the survey number are set as the strengths of sample distribution in the several strata.

To remove the subjective element, the individual sample in each stratum is selected with the help of Tippett's random numbers. For the location of the plot in the 'thalai', a pair of random numbers are selected, to mark out from the south-west corner of the 'thalai', the dimension along the length and from thence at right angles into the 'thalai', to get at the starting point of the plot. In the exploratory work done in the Tanjore delta, standard errors were determined from the harvests of plots, varying in size from a few square feet to several cents, just as row yields are computed on Government Farms, to get at the proper size of a plot for an experiment. To have a low *border effect* of the plants, in the periphery of the plot, harvests of plots of different shapes, rectangles and squares in the Tanjore delta, and rectangles and circles and equilateral triangles of different sizes in the Kistna delta were conducted. To estimate the yield for a 5% standard error, a rectangular plot, 50 links by 20 links was found to be the best.

Ways to Improve Crop Estimation. To improve crop estimation, the conduct of crop-cutting experiments, under the stratified random sample survey, with dense and heavy sampling, to reduce the magnitude of the standard deviation, may have to be continued for a large number of years,

under a competent statistician. The survey of the un-surveyed areas may be completed by the levy of a suitable cess. The yields from the crop cutting surveys may be correlated with the estimates from the other agencies at work towards the same object. The karnam should make the crop estimate against each survey number in the 'adangal', in pounds per acre, instead of as anna-crop. In villages, in some parts of the province, the operations of the bagging to standard weight or standard measurement, are auctioned out and the proceeds therefrom are spent under a chalked-out programme, by a constituted Trust. Particular persons are employed by the Trust, for a moiety, to carry out the work in the field and at the threshing floor. Correct statistics may be obtained from this agency (known as 'kolagaram', in the Telugu Districts), if the Village Officers are made to utilise this body for the work. Estimations not merely by the geographical districts, but for deltas, distinct tracts and regions may be made to serve the interests of the Industry (which depends on raw materials) and the Trade.

Taxation in the intermediary stages of turnover, when replaced by the tax at the source, on the field, as in tobacco, will greatly improve the out-turn estimates.

The importance of statistics in tackling the food crisis cannot be too well emphasised. As Dr. A. B. Stewart pointed out, it is only in the past 10 to 15 years that the value of statistical science, in the study of agricultural problems in India has been adequately realised.