in January, or the total cropped acreage for the season: and how are any of these to be estimated from a sample drawn over a lengthy period? As for the remaining crops, estimate 8 for pulses is 2,963,000 acres, as against 2,903,000 for estimate 9, and the sugar-cane estimates show similar intriguing differences.

I have no doubt that there is some very simple explanation of all these divergencies, and that this would have been made quite clear if circumstances had permitted Professor Mahalanobis to submit his paper in the customary form for printing and distribution to Fellows at this meeting.

Time will permit only one further very brief point. Professor Mahalanobis said that at the last stage, at the request of the Government, an estimate of 312,700 acres was also given for the area under potatoes, only about 0·26 per cent. of the total geographical area covered by the sample survey, and he added that this supplies a good idea of the wide range of the survey. It would therefore be interesting to have details of this estimate and to know the sampling errors involved, how they were calculated, and how they compare with those of the other estimates.

Dr. George concluded by expressing the deep pleasure it gave him to second the vote of thanks for such a valuable paper from so distinguished a visitor.

The vote of thanks was then put to the meeting, and carried unanimously.

Dr. M. S. Bartlett, after adding his personal thanks and his welcome to Professor Mahalanobis, said that there was one incidental point raised by the last speaker, Dr. George, on which he also was not very clear, and that was the precise meaning of " physical fluctuations " as distinct from " sampling variations."

When considering the paper generally, what he felt was perhaps not so much the novelty of the methods used, but the value of the integration or synthesis of methods used to meet a variety of demand. It was rare to find one department which used these methods for such varied activities as agricultural crops and the investigation of the cost of living and family budgets. Possibly in this country, especially on the social and economic side, those concerned with similar investigations would be studying further the methods which Professor Mahalanobis had described. In particular, there was a great deal to be said for this study of variability, a point which was well recognized in agricultural work, but which had been brought out that evening on the social and economic side. It not only enabled one to judge the accuracy of one's averages at the end, but it gave invaluable information on the material itself.

To take an example. Supposing they made an enquiry into the consumption of a particular food in connection with rationing. Such a study of variation, not only between the broadly classified groups of consumers, but within those classes, would not only give the accuracy of the mean level as shown by the sample, but it would give the variation between those classes. A knowledge of such variation was desirable in order to estimate the change in the mean level of consumption resulting from rationing and the amount of individual hardship which would be entailed if the people were rationed at definite mean levels.

There was one further theoretical point he wanted to mention. Although it was not covered by the paper that evening, it was mentioned in the paper in the *Philosophical Transactions* which had been referred to. He thought it had some relation too with the last Table which Professor Mahalanobis had produced, which he gathered had something to do with the question whether units were random and independent or not. In his paper in the *Philosophical Transactions* Professor Mahalanobis referred to what he called space correlation functions: this was theoretically an interesting concept related to the time correlation functions which occurred in time series. These had been encountered before; they had, for example, been used by Sir Geoffrey Taylor in the theory of turbulence. The property of stationarity in time series was the property of homogeneity in space correlation functions. Further questions that arose were: Were these functions isotropic?—that is, independent of the direction in which one was measuring the correlation—the answer in agriculture was probably " no ": and Did these functions ever show periodicity?

The sort of question which one asked in agricultural design work was usually answered on the basis of a uniformity trial, from which was worked out semi-empirically what was the optimum design. The same answer (for constant variability) must follow from a knowledge of the correlation function. Such an alternative approach did not of course affect the final analysis of any data which was accumulated on a basis of the design finally decided; that followed the standard analysis of variance along the lines that had been described.

The following contributions were received in writing after the meeting:

Major M. D. W. Elphinstone: Professor Greenwood mentioned his own admiration for Professor Mahalanobis's mathematical skill: I also worship from afar. But even more do I admire the courage which has enabled Professor Mahalanobis to build up his organization in the face of all the discouragements and difficulties which he has had to face.

I have during the war been responsible for certain administrative statistics in G.H.Q., India, and I can imagine some of the difficulties overcome.

In the first place, there is apathy—an apathy difficult to imagine even in our own constant struggle against wilful ignorance at home. Even those who care for good work are apt to be worn down by the continuous output of energy required to get any new idea accepted. The strain is greater in a hot climate, and appears to affect white and brown-skinned races alike.

Then there is the temptation of intellectual dishonesty. Professor Mahalanobis gave examples throughout his paper: the temptation of the field worker to "fudge" his figures, the political pressure resulting in an inaccurate census, the hint of the virtual suppression of an unpalatable report. If Professor Mahalanobis is not absolutely honest in his own work, then he must have practised on us this evening one of the subtlest deceptions of his career. Heat engenders fixed opinions and unreasoned prejudices, and I know how easy it is to hunt for figures to prove a theory rather than to hunt in the figures for the truth.

Then there is the administrative skill and thoroughness with which his investigations are planned. His account of the size of his organization must have made some of us jealous, but he is right to emphasize the factors of time and cost even in his Bengal surveys. Bullock-carts are a slow way of moving about; his field workers must spend much of their time travelling. Then he let fall a mention of work done near Karachi—only some 1,500 miles away. Only by the most careful economy can so much work be done in such conditions by so small a staff.

To give more point to my praise, I may perhaps add that having discarded one of my staff for " negative efficiency " I felt that my section was shaping well. We carried out a small survey on the output of work by coolies, and I designed most carefully all the working sheets and rules for checking. When the figures came up to me, it appeared that the discarded one's successor (specially picked as likely to do well in such work) had not troubled to see that decimal points were in the right place, being of the opinions that (1) I should not notice and (2) that even if I did it would not matter, as the mistakes would average out. Not all people are like that in any part of the world, but it is clear that Professor Mahalanobis has had enough of them to have had to devise techniques for protecting himself against them, and, moreover, has used by-products of these techniques to yield useful statistical information.

Anywhere in the world his achievements would be noteworthy, but as Professor Greenwood admires his work in Combinatory Analysis, so I, who have had some very small experience of the difficulties he has had to face, admire the skill with which administrative troubles unconceived in this country have been overcome.

MR. D. M. SEN: The speaker has emphasized, and Dr. Yates has reiterated, the difficulties of dealing with recording mistakes in sample surveys in different countries. Dr. Yates has introduced into the discussion the much-abused concept of the " intellectual competence " of the field investigators. I have been associated, for some time now, with large-scale sample surveys in Great Britain. Recording mistakes are not a regional phenomenon, not even in their scale. They are common wherever large-scale surveys are undertaken. It would be totally wrong to try to correlate recording mistakes with " the state of intellectual competence," even if " intellectual competence " could be measured and calibrated, or averaged and graded, for countries as a whole.

To counter recording mistakes, various checks are necessary. I may perhaps be allowed to give some instances from my own firm, which is thought to be one of the largest sample survey organizations in the world. Out of the ten departments which share, between them, the whole work of these sample surveys, beginning from the collection of the data to their presentation to clients, two of the largest departments are charged with the functions of " checking field data " and " inspecting processed data." The Tabulating Department, moreover, applies several checks on its own work (punching, etc.), and on Checking Department's work, which has supposedly already checked the data recorded by field investigators. I remember a somewhat irritated fieldman asking the question, " who checks Checking Department's work? ". As a matter of fact, the Tabulating Department itself checks Checking Department's work to an extent, as I have mentioned above, but there are other departments, too, which are doing exactly the same thing at various stages of processing the data. The Tabulating Department, for instance, uses the " unit " check on the Hollerith to ensure that purchases plus previous stocks equal sales plus present stocks on each card. The cards may have been checked rightly from the original information sheets which were vetted by Checking Department previously; yet it is felt necessary to employ the " unit test." Similarly for " unit costing." The fieldman records purchases in units and the total value. The cost per unit is computed, which serves as a check on the accuracy of fieldmen's records, since this unit purchase price is compared with the unit purchase price of other shops for the same goods or similar goods, and also compared against the " unit cost " price as recorded a month or so previously in the previous period's survey. This cost per unit is used by Tabulating Department on the Hollerith. The units are multiplied by the " unit cost " to arrive at the total purchase price. These totals for different shops are added up on the Hollerith, and their grand total for each item or brand from the Hollerith serves as a check against the sterling total, which the Checking Department has got on their comptometers for the purchases of the same item or brand.

It is therefore clear that within departments themselves there are various checks. There are