UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL

SUB-COMMISSION ON STATISTICAL SAMPLING

REPORT TO THE STATISTICAL COMMISSION ON THE SECOND SESSION OF THE SUB-COMMISSION ON STATISTICAL SAMPLING HELD FROM 30 AUGUST TO 11 SEPTEMBER 1948*

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INTRODUCTION

1. The Sub-Commission on Statistical Sampling held its second session during the period 30 August to 11 September 1948, in Geneva. The Sub-Commission elected Mr. P. C. Mahalanobis as its Chairman.

2. The following attended the session:

Members: Mr. G. Darmois,
Mr. W. E. Deming,
Mr. P. C. Mahalanobis,
Mr. F. Yates;

Consultant: Mr. R. A. Fisher;

Secretariat: Mr. W. J. Bruce (Secretary to the Sub-Commission),
Mr. W. R. Leonard (representing the Assistant Secretary-General in charge of Economic Affairs).

Representatives for specialized agencies:
International Labour Organization: Mr. J. W. Nixon
Food and Agriculture Organization: Mr. M. J. B. Ezekiel.

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3. The Sub-Commission welcomed the presence and participation in the discussions of the following statisticians interested in sampling: Mr. F. Brambilla and Mr. G. Parenti of Instituto Centrale di Statistica, Rome; Mr. N. Keyfitz of the Dominon Bureau of Statistics, Ottawa; Mr. R. Levy-Bruhl of the Institut National de la Statistique et des Etudes Economiques, Paris; and Mr. A. Linder of the University of Geneva.

CHAPTER I

AGENDA

4. The Agenda for the second session of the Sub-Commission was as follows:

I. Adoption of Agenda;
II. Election of officers;
III. Consideration of interim report regarding sampling experiences in different countries;
IV. Standardization of technical terminology and points to be covered in report of sample surveys;
V. Consideration of sampling methods in family budget inquiries;
VI. Discussion of proposals for the exchange of technical information on sample surveys;
VII. Consideration of the use of sampling in relation to national income estimates;
VIII. 1950 World Census of Agriculture;
IX. The use of sampling in manpower statistics;
X. Consideration of the reports of the Statistical and Population Commission relating to: (a) the 1950 Census of Population, and (b) the programme for education and training of statisticians;
XI. Programme of future work;
XII. Other Business.

CHAPTER II

FUNCTIONS AND AIMS OF THE SUB-COMMISSION ON STATISTICAL SAMPLING

5. One of the initial recommendations of the nuclear Statistical Commission was that a Sub-Commision on Statistical Sampling be established (E/39, 16 May 1946). It was felt that a wider use of modern sampling methods could improve statistics in all parts of the world by providing statistics on subjects not now covered, and by increasing the speed and reliability of many surveys now conducted by complete counts and partial coverages. The Economic and Social Council in approving this recommendation authorized the Statistical Commission to establish a Sub-Commission on Statistical Sampling of not more than nine members (E/76/Rev.1). The Sub-Commission on Statistical Sampling was established by the Statistical Commission, February 1947 (E/264).

6. The terms of reference recommended in the report of the first session of the Sub-Commission on Statistical Sampling (E/CN3/37) were approved by the Statistical Commission (E/795). In advising the Statistical Commission, the Sub-Commission has the responsibility not only for promoting the improvement of methodology in statistical sampling and examining the use which is being made of statistical sampling in different countries, but also of considering how sampling may be utilized in developing statistics to meet the needs of Members and Organs of the United Nations, specialized agencies and non-governmental organizations.

7. With these aims in view the first session of the Sub-Commission met September 22-27, 1948 and the agenda included problems of sampling relating to the 1950 World Census of Agriculture raised by the Food and Agriculture Organization; consideration of the place of sampling in obtaining census data as part of the population censuses to be taken in 1950 as requested by the Statistical and Population Commissions; and preliminary discussions on the application of sampling techniques to family budget enquiries in response to a request by the International Labour Office. The Sub-Commission was also able at its first session to formulate general observations on the use and applicability of sampling methods (E/CN 3/37).

8. Certain types of problems in the theory and applications of sampling are of continuing interest to the Sub-Commission. Among those are the examination of such current sample surveys, as were reported to the Sub-Commission, with the purpose of deciding along what lines technical guidance and educational programmes might be recommended. The Sub-Commission also gave attention to the development of standard terminology and concepts of sampling survey methods.

9. Further consideration of sampling as applied to family budget surveys, population and agricultural censuses, and national income statistics was also given at the second session. In addition, the advice of the Sub-Commission was requested by the International Labour Organization on the use of sampling in obtaining manpower statistics. In the development of its own programme for the improvement of sampling methodology and its use in various countries the Sub-Commission has prepared a memorandum containing some general principles of sampling, and recommendations concerning the preparation of reports of sampling surveys.

10. In organizing its programme of work the Sub-Commission requested that materials prepared for agenda items on future sessions be circulated to members during the intervals between sessions in order that a detailed and critical review of the material may be possible. Members of the Sub-Commission may wish to send the Secretariat comments and observations on such materials and also to request further information when necessary.

11. The Sub-Commission at its second session adopted the informal procedures of a working party during many of its meetings, inviting the comments and contributions of visiting statisticians in the discussions. The Sub-Commission wished to record its appreciation of the generous assistance provided by visiting statisticians, and suggested that at subsequent sessions statistical experts from different parts of the world be encouraged to meet with the Sub-Commission and contribute their knowledge and experience to the solution of the problems under consideration.

CHAPTER III

Sampling surveys of current interest and exchange of information

12. The terms of reference of the Sub-Commission direct it to "examine the use which is being made of statistical sampling in different countries, and in different fields of subject matter" (E/795). The Secretariat was requested to collect information relevant to this matter, and to report to the second session of the Sub-Commission. Information was requested from sixty countries on particulars regarding the more important sample surveys which had been undertaken. Replies were received from twenty-five countries of which twelve reported the use of sample surveys. An interim report was prepared for the second session of the Sub-Commission (E/CN. 3. Sub. 1/9).

13. The Sub-Commission welcomed the information available in the interim report, but noted that further technical information was required in many cases. It also heard supplementary reports on details of other sample surveys known to its members. Additional information and comment was given by the statisticians who attended the meetings of the Sub-Commission.

14. The information assembled regarding the sampling experiences of the different countries was valuable, and would be useful to the statisticians of the different countries. The Sub-Commission recommended that for surveys involving generally applicable principles of sampling further information in regard to their design and sample selection should be sought. For those surveys where the designs were simple, information given in the interim report was adequate. A revised paper should be prepared to include such additional information and to include also particulars of additional surveys which became available after the interim report was prepared. The Sub-Commission considered that the term "sample survey" was at present used for a wide range of partial surveys. The Sub-Commission considered that the use of the term "sample survey" should be discouraged in cases where the sample selection was not made by a random or equivalent procedure.

15. The Sub-Commission therefore requested:

a) that the interim report be revised to include more details on the important surveys and that this report be given general circulation to persons interested in the theory and applications of sampling;

b) that the Secretariat continue to develop contacts with correspondents in different countries and continue to collect information on significant current sample surveys and to make this information available to persons responsible for planning and conducting surveys. Very often the information asked for from the different national offices will be supplied in the form of published or previously prepared reports;

c) that the Secretariat should draw the attention of the correspondents to the points incorporated in the memorandum of recommendations concerning standard terminology for reporting sample surveys prepared by the Sub-Commission on Statistical Sampling (see Chapter IV);

d) that additional reports on sample surveys be prepared and circulated from time to time by the Secretariat. Such reports should reflect, as far as possible, the standards outlined in the Sub-Commission's memorandum of recommendations.

16. The Sub-Commission also examined the question of exchange of information upon technical details of sampling projects and considered that additional efforts towards the interchange of such information are necessary in order that successful experience in one country can be utilized by others and difficulties avoided. The Sub-Commission was of the opinion that detailed technical materials should be collected. Efforts should be made to include information upon surveys conducted by non-governmental organizations.

17. The technical materials to be sought in the case of the more important sample inquiries should include:

a) reports covering items such as sample design, accuracy attained, methods of sample selection, field work, and analysis;

b) instructions used by the supervisory and field staff;

c) other relevant memoranda and papers dealing with the applications of statistical sampling to economic and social investigations (it being assumed that the theoretical aspects of sampling will be sufficiently reported in the technical journals).

18. The Sub-Commission suggested that materials requested should generally be those which were readily available.

19. Following the assembly of relevant materials the Secretariat should circulate a brief abstract or list of materials to the members of the Sub-Commission, to national statistical offices and to other interested agencies or individuals indicating the sample surveys of different countries, technical details of which had been made available. Upon request of an interested organization, the Secretariat should prepare a reply dealing with the points specified in the request.

CHAPTER IV

STANDARDIZATION OF TECHNICAL TERMINOLOGY AND POINTS TO BE COVERED IN REPORTS ON SAMPLE SURVEYS

20. The Sub-Commission spent a considerable part of its time discussing the content of and preparing a memorandum dealing with the items of information which could most beneficially be included in reports of sampling investigations. It also considered the terms and concepts which would be useful in describing the technical processes used, and prepared definitions of these terms and concepts. The memorandum, " Recommendations Concerning the Preparation of Reports of Sampling Surveys," appears as an addendum to this report.

21. The Sub-Commission considered that if accounts of sampling investigations included the points enumerated, and if they dealt with the technical aspects of sampling processes in accordance with the recommended terminology, it would become increasingly possible to improve sampling practices in many important respects. The Sub-Commission believed that the wide circulation of reports, prepared generally in accordance with the suggestions contained in the memorandum, will foster international exchange of experience, and will suggest the use of sampling in various undertakings now being carried on by complete counts or by non-random partial surveys.

22. The Sub-Commission recommended that the Secretariat should distribute the memorandum to all interested statistical offices and statisticians, drawing their attention to the desirability of following as far as possible the recommendations in the memorandum in subsequent reports on sampling investigations. The Sub-Commission stated that it would be glad to receive, through the Secretariat, comments and suggestions with reference to the content and usefulness of the memorandum.

23. The memorandum contains the following sections: general description of the survey; design of the survey (with definitions of terms and notes on the applications of particular methods); method of selecting sample-units; personnel and equipment; costs; and accuracy of the survey.

CHAPTER V

CONSIDERATION OF SAMPLING METHODS IN FAMILY BUDGET ENQUIRIES

24. The Sub-Commission considered a request from the International Labour Office regarding the application of sampling in family budget studies. Some general recommendations were made at the first session of the Sub-Commission, and more specific information was requested on present methods. An account of such methods was presented by the International Labour Office (E/CN3/Sub.1/5).

25. The subject was discussed at the second session in the light of this information. In view of the complexity of the subject, and the varying economic and social conditions in the different countries, the Sub-Commission considered it was not in a position to make detailed recommendations without considerable further investigation, which it was unable to undertake at their second session. However, in the course of the discussion a number of general points emerged. The Sub-Commission considered that these were worth emphasizing, since, although they may be well known to the most advanced workers in the subject, it was apparent, from the information submitted, that they had been insufficiently taken into account in many recent surveys.

26. Any family budget enquiry which is designed to supply quantitative regional and national estimates, covering either all families or families of a particular type, must be based on a proper random sample. The information (in E/CN3/Sub.1/5) gave evidence that methods of selecting families or households in many surveys were such that no attempt can have been made to fulfil this condition.

27. The Sub-Commission is aware that the failure to take random samples is in many cases due to the inherent difficulty of collecting the required information, thus leading to the selection of such families as have promised their cooperation, often families with whom the field investigators are already acquainted in some other connexion.

28. Although such a method of selection is very unlikely to give reliable results, the situation will not be improved simply by taking a random sample, if this results, as it has done, in lack of response from a large proportion of the households selected for the sample. The practice of substitution, by which a non respondent family is replaced by another, either drawn at random from the original frame, or selected by judgment or specification, does not resolve the difficulty.

29. The main problem therefore appears to be that of improving methods of collecting the information, so that surveys can be undertaken on a proper random sample with confidence that the amount of non-response will be sufficiently small so as not seriously to invalidate the results.

30. Improvement of methods of collecting the information can only result from research and experiment, much of which must be carried out in all or many of the countries concerned, since a method which may be eminently suitable for one set of conditions may be entirely impracticable in another.

31. The Sub-Commission is aware that a considerable amount of such research has already been undertaken in certain countries. They did not, however, have opportunity to review the research as a whole. Subject to such review, it appeared to the Sub-Commission that research might be directed along the following main lines:

a) Comparison of the interview and account book methods. It may be noted here that the account book method cannot be applied in all circumstances—it is useless, for example, where illiteracy is widespread—and is in any circumstances likely to result in a much greater degree of non-response, or of failure to complete the records over the required period.

b) Length of period for which data are sought from individual families, and whether the period should be continuous or in separated parts, *e.g.* one week in each quarter.

c) Simplification of questionnaires, with due regard to the information required.

d) Subdivision of the questionnaire, some items being collected from one set of families, others from another set. One possible method is to submit a short list of basic

questions to all families in the sample, and to subdivide the total schedule in suitable sub-groups of questions for different sub-samples of the main sample. (This is an application of phase sampling, see " Recommendations concerning the preparation of reports of sample surveys "). The set of questions must be so designed that all the required inter-relations are covered.

e) Improvement of the technique of interviewing. In this connexion the Sub-Commission wish to emphasize the importance of endeavouring to secure the cooperation of all members of the family. It frequently happens, for example, that the wife is ignorant of some or all the expenditures of her husband.

f) Tests of different classes of interviewers, and investigation of differences between individual interviewers.

g) The effect of inducements, such as remuneration and of propaganda, etc., on the degree of cooperation.

h) Tests of the alternatives of asking for income as well as expenditure, and striking a balance, or of asking for expenditure alone, the latter may be superior where there are motives for concealing certain sources of income.

32. Investigation of all the above points must be mainly by means of proper comparative tests of alternative procedures. For this purpose the employment of the techniques developed in modern experimental design is essential.

33. Different methods of collecting the information, different questionnaires, etc., cannot be tested on the same family, and the type of experimental design required is therefore analogous to that used in agricultural field trials, in which each plot receives one of the experimental treatments, families being here equivalent to plots. As a simple example, alternative ways of comparing the account book method with the questionnaire method, with or without the introduction of different investigators, may be considered.

34. If the whole test is carried out by a single investigator pairs of families may be selected, the two members of each pair being chosen so as to be as alike as possible. The account book method is then assigned at random to one member of each pair, the questionnaire method being assigned to the other member of the pair. This is exactly analogous to a randomized block design for two treatments, and the accuracy of the comparison can be estimated, and its significance tested, by the analysis of variance technique appropriate to this design.

35. This type of design can easily be extended to include more than two alternatives. With three investigators, for instance, sets of six families can be selected, and the six combinations of the two methods and three investigators assigned at random to the six families of each set. This is a simple example of pictorial design, the two factors being methods and investigators, enabling not only the differences between methods and between investigators to be assessed, but also any differential performance between the investigators on the different methods ; e.g. there may be little difference between investigators when the account book method is used but one of the investigators may be outstanding with the questionnaire method.

36. Different investigators may, of course, be deliberately associated with different methods, e.g. investigator A may be used on the account book method, and investigator B on the questionnaire method, but in this case it must be recognised that any observed difference may be due either to investigators or methods, or a combination of both. In

general, therefore, it is best to design the test so that the effects of investigators and of methods can be separately assessed.

37. An alternative to the formation of sets of which the members are as alike as possible is the use of interpenetrating samples, one such sample being assigned to each of the method-investigator combinations which it is designed to test. This procedure (which is not in fact formally very different from the other) has the advantage that no preliminary information need be collected about the families. Further more, lack of response will not complicate the analysis of the results to the same extent as in the randomized block method, where lack of response in one of a set, for instance, requires the use of the "missing plot technique" if the remainder of the results of that set are to be utilized. On the other hand if there is full response the use of sets will result in greater precision since the inter-set variance is eliminated from the results.

38. In the above discussion nothing has been said as to the way in which the families on which the tests are to be carried out are to be selected. Clearly they must be reasonably representative of the types of family on which the final surveys will be conducted. It is useless, for example, to test out methods on middle class families if data are required for working class families. On the other hand if overall estimates for the population are not required there is no absolute need for the test material to be selected strictly at random—it may for instance be considered advisable at any rate in the initial stages, where many different methods are under investigation, to utilise families whose cooperation can be assured, e.g. families contacted through some social welfare organization.

39. Even if contact is made through a social welfare organization, random selection should be practised within this limited population. The organization should in fact be asked to provide a list of all families with which it has contacts. The statistician should select the sample families from this list, which can then be approached by the organization. If the selection of sample families is left with the organization, a much less representative sample of these families with which they have contacts is likely to be obtained.

40. Clearly if contact is made through some social welfare organization, even with the above precautions, the results will not necessarily be fully valid for the more general population; in particular the amount of non-response is likely to be far less than will be experienced with a random sample.

41. Consequently a final test of the most promising procedures should be made on a fully random sample. This may often form part of the full scale survey, using interpenetrating samples. In any case it is always advisable to include tests between investigators in any full scale survey.

42. However well comparative tests of the above type are planned and executed there are certain types of error which will not be determined with certainty by their aid: if, for example, all families tend to minimise certain types of expenditure, e.g. on alcoholic beverages, betting, etc., no comparative tests will ascertain the full magnitude of such errors. It is therefore of the utmost importance to take advantage of all possible available external checks, and it may be well worth while to determine the amount of expenditure on different classes of goods and services, independently by a survey of retail sales, etc. This can only be done on a regional basis if all major transfers of goods and services across the regional boundary are taken into account, and consequently requires most careful planning and attention to detail.

43. Surveys of retail sales of this type can be combined with surveys of retail prices which are in any case required for the construction of cost-of-living indices. The evidence presented to the Sub-Commission indicated that in this respect also the principles of random sampling had in many cases been inadequately adhered to.

44. Finally the Sub-Commission wished to express its conviction that continuing enquiry by means of small scale successive surveys was likely to be much more fruitful in this field than large scale surveys only undertaken at long intervals. Successive surveys at frequent intervals not only provide much more up-to-date information, together with information on trends, but also enable a proper survey organization of skilled investigators to be built up and maintained—a most important point in this field where all enquiries are so difficult. Once the problems of collecting the required information have been solved the use of modern sampling methods will enable all necessary accuracy to be obtained with quite small samples.

CHAPTER VI

APPLICATION OF SAMPLING METHODS IN NATIONAL INCOME STATISTICS AND RELATED AGGREGATES

45. In the report of the first session of the Sub-Commission, note was taken of the fact that important studies in the field of national income and related aggregates were being carried on in a number of countries. At the request of the Statistical Commission the Sub-Commission considered the ways in which sampling might contribute to the development and improvement of statistics in this field. It was pointed out that evaluation of national aggregates with a sufficient degree of accuracy in many cases necessitated the use of improved techniques involving modern sampling methods.

46. A brief memorandum on the concepts and problems of national income statistics was prepared for the second session (E/CN. 3/Sub. 1/7). Additional information was presented citing examples where non-random partial surveys were now being undertaken and instances in which the accuracy of the data obtained could be considerably improved by collecting data by proper sampling methods.

47. The document indicated that there are three general methods of preparing national income estimates, each reflecting a different and significant aspect of the same complex aggregate, namely, (a) net national product, (b) the sum of the distributive shares, and (c) net national expenditure. The published official statistics in almost all countries, however, are insufficient to build up the aggregate irrespective of the approach selected.

48. Where the aggregate sought is the net national product, the net values of production in different industries are derived from gross values of production which are available in a number of countries from censuses of production. The calculation of business expenses of all kinds, however, needs detailed study. The collection of the necessary data from large enterprises may generally be based on complete coverage and so far as the middle-sized and small enterprises are concerned it has been found possible to develop proper sampling methods. Also, figures for certain types of activities such as handicrafts, maintenance and repair shops, agriculture, independent professions, etc., are not usually available in satisfactory forms in any country and in view of the costs involved in complete surveys, such data can only be estimated by sampling.

49. Where the aggregate sought is the sum of distributive shares, sampling offers a method of estimating salaries and wages, particularly those below tax limits or outside social insurance coverages. Correct estimates of profits of individual firms and especially

of the small ones can be done on a sampling basis. Proper design of sample surveys is particularly important in this field in view of the skewness of income distribution.

50. Where the aggregate sought is the net national expenditure, statistics of retail sales and family living expenditures have almost invariably been collected by non-random partial surveys and here again, modern sampling methods can improve the accuracy of the figures and reduce the costs of collection. Sampling methods may also be used in measuring capital formation and the physical volume of capital formation.

51. Decisions as to what method of approach should be taken, or to what extent the aggregates may be sub-divided, are at present conditioned more by the availablity of official statistics than by the method of approach most suitable to the purposes of the analyst or administrator. Such restrictions may, however, be reduced to a great extent through modern developments in sampling ; additional data of required accuracy in some categories of national income can be collected with low costs and with speed and accuracy. This will enable more than one set of data to be developed for analytical purposes using alternative approaches in the compilation of the national income totals. Also, because of the greater possibilities of collecting different types of data by sampling, the accuracy of the national income computed in one way may be checked by building up a similar aggregate based on a different method.

52. Where the components entering into the aggregates are of small dimension, such as payments in kind in a highly industrialised economy or contributions to charitable organizations by corporations, large relative errors have little effect on the total. Even in such cases modern sampling practices, where they can be developed, will have the advantage of indicating the range of error of the estimates.

53 The Sub-Commission requested that its members be kept in touch with the developments in studies relating to national income and would welcome further information from the Secretariat in regard to specific sample surveys carried out in different countries with a view to obtaining data for national income estimates. It also requested that the report on national income statistics being prepared by the Statistical Office of the United Nations be circulated to the members of the Sub-Commission to enable them to suggest at subsequent sessions useful methods in improving data available for use in national income computations.

CHAPTER VII

1950 WORLD CENSUS OF AGRICULTURE

54. A memorandum (E/CN. 3/Sub. 1/8) prepared by the Food and Agriculture Organization for consideration by the Sub-Commission contained a statement regarding the preparations for the censuses of agriculture which are to be taken in 1950. The memorandum, and the accompanying explanations, drew the attention of the Sub-Commission to the great need for printed material containing information on sampling methods and their application to agricultural problems, and to the equally great need for training institutes and programmes to assist in developing the necessary skills. As regards training material, it was reported that the Food and Agriculture Organization had found the report of the first session of the Sub-Commission extremely useful as well as the statement on the the uses of sampling prepared under the auspices of the Sub-Commission and circulated by the Secretariat. At the first session of the Sub-Commission Dr. F. Yates had agreed to prepare a manual on statistical sampling as applied to agriculture which could be utilized as training material in connexion

with the 1950 World Census of Agriculture. The Sub-Commission at its second session noted with approval that the work on this manual was well advanced and that it might be available towards the end of the year.

55. The Sub-Commission also noted with approval that at the meeting held in December 1947 by the Food and Agriculture Organization, problems of the agricultural census in under-developed areas were discussed, as well as the desirability of applying sampling methods in these areas. In respect to British colonial territories tentative arrangements had been made to institute a training course in sampling if there was sufficient demand for it. Reference was also made to the training institute in Mexico City to be undertaken through the Joint efforts of the Government of Mexico, the Food and Agriculture Organization, the Statistical Office of the United Nations, and possibly the Inter-American Statistical Institute.

56. The representative of the Food and Agriculture Organization also called attention to the very great need to develop and improve current statistics of crop conditions and forecasts, as well as infrequent census statistics on crops and acreage. In many respects the need for current statistics was even more urgent than the need for census statistics. In this connexion the Sub-Commission requested the Secretariat, with the cooperation of the Food and Agriculture Organization, to prepare a report on existing methods of estimating current agricultural production statistics for consideration at the third session. The Sub-Commission was also interested in receiving copies of the report of the study now being made by the Food and Agriculture Organization on the Methods used in preparing estimates of the acreage and production of rice with special reference to crop-cutting and sample surveys. It was agreed that information on these matters, when available, be sent to the members of the Sub-Commission in connexion with the work of the third session.

CHAPTER VIII

Manpower statistics

57. The Economic Commission for Europe (through its Manpower Committee) requested the International Labour Office to collect information on manpower deficits and surpluses in European countries as a contribution to European recovery programme. In view of the unsatisfactory nature of the statistics of manpower available in many countries, the ECE requested that the ILO study the possibility of applying the most appropriate technical methods, particularly the method of sampling, to the development and improvement of such statistics, and that it should seek the advice of the Sub-Commission of Statistical Sampling (E/CN. 3/Sub. 1/10).

58. The Sub-Commission reviewed the existing practices of data collection in regard to manpower followed in a number of countries such as Canada, France, United Kingom and United States, and noted the variations in the sampling methods used. It was recognized that suitability of methods of data collection was dependent on the conditions peculiar to a country and that it would not be appropriate to outline a standard plan to be adopted by all countries. It was pointed out, however, that where such data were not obtained as by-products of administrative practices, some form of sampling seemed to be the only way practicable of collecting the information. Sample surveys would be especially suitable when it was necessary to obtain figures relating to the manpower of a whole country including unemployed workers, workers engaged in agriculture and in small and scattered enterprises. Such sample surveys of the population have been adopted in some countries by designing

a system of stratified samples of households ; these are visited at regular intervals by interviewers who obtain information on the employment status of each member of the household.

59. While the initial costs of sample surveys of the labour force might be considered high in many countries, in absolute terms, it was pointed out that in relative terms the cost was reasonable especially when the much higher costs of alternative methods were considered.

60. After a discussion of sampling in relation to the labour force, the Sub-Commission agreed upon the following points :

a) The Sub-Commission reviewed the recommendations of the Sixth International Conference of Labour Statisticians on labour force suveys, and noted the considerable emphasis given to the need for an infrequent but periodic complete count to establish a "bench-mark" or point of reference for monthly or quarterly current surveys on a sample or partial basis. The Sub-Commission pointed out that even in countries where the census data may be considered reliable and complete, the data were slow in becoming available because of the magnitude of the task of collection and tabulation, and were consequently likely to be out-of-date even at the time of publication. Moreover, each country was faced with changing administrative needs for statistics of this kind and these could not always be anticipated and included in censuses. In addition, the economic and social problems and the concepts and definitions associated with them are subject to change so that a bench mark may become of limited value as a point of reference. The Sub-Commission recognized bench-marks, in reference to manpower statistics, as being chiefly of value in providing a frame for sample surveys which could be adapted to changing needs and conditions, concepts, and definitions, and could produce the results needed at the appropriate time.

b) As in other similar situations, experience shows that the use of small successive sample surveys could provide up-to-date statistics at a low cost. The use of this method, however, depends upon an adequate knowledge of sampling technique.

c) The Sub-Commission pointed out that information required by different government departments may be collected through one common agency and thus the share of costs for any one department may be reduced to a minimum. It was considered very important, however, not to overload any one survey since overloading may be a cause of unreliability. The Sub-Commission proposed to give further attention to the use of sampling methods in manpower surveys at the next session.

CHAPTER IX

1950 CENSUS OF POPULATION

61. The attention of the Sub-Commission was drawn to the reports of the Population Commission (E/805) with reference to their recommendations as to the desirability of the use of sampling methods in census-taking. The Statistical Commission at its third session in April 1948 had pointed out that these methods could, under certain conditions, be effectively applied to provide comparable data on such census items as total population, age, sex, marital status and types of economic activity.

62. The Population Commission which had held its third session after that of the Statistical Commission had requested that the Secretary-General draw the attention of Member Governments to the Statistical Commission's observations and also to the report of the first session of the Sub-Commission (E/CN. 3 37). It further stated that sampling methods "may be especially valuable as a means of assessing and improving the quality

of census data and of extending their coverage to subjects and population groups which it may not be feasible to include in complete enumerations." The Population Commission also considered it of importance that methods and facilities for sampling in connexion with future censuses of population be developed by Member Governments, and endorsed the views and recommendations of the Statistical Commission and the Sub-Commission on Statistical Sampling regarding the request that adequate provision be made for training in statistical sampling methods and for the rendering of expert advice and assistance in these fields to Member Governments who might request it.

CHAPTER X

Programme for the education and training of statisticians

63. The Sub-Commission, having considered the matter of education and training at its first session, discussed the recommendation of the Statistical Commission (E/795) referring to a programme of statistical education and training. The resolution, approved by the Economic and Social Council at its seventh session (149 VII), directs the Secretary-General to arrange for a survey of the needs for education and training in statistics, for the formulation of a programme to meet these needs, and for a report on the means by which such a programme may be put into effect.

64. The members of the Sub-Commission discussed the problem with special reference to the need for statisticians adequately trained in modern sampling methods, and made various suggestions designed to facilitate an understanding of the needs and purposes of statistical training. The members of the Sub-Commission agreed that certain distinctions should be kept in mind in the study of the problem.

65. It was considered important to distinguish between education and training; the former referring principally to formal university instruction in statistics, and the latter to the practical aspects of the application of statistical methods to actual problems. It was agreed that training should include, in addition to active experience in the conduct of statistical work, aspects of practical statistical administration which are essential to the efficient conduct of sample surveys.

66. It was further agreed that a distinction should be maintained between what the United Nations should appropriately undertake with respect to a programme of education in basic theory and methodology and what individual countries and national statistical administrations should be expected to undertake. It was the view of the Sub-Commission that the United Nations might confine its activity to surveying and making suitable recommendations to correct deficiencies, and that individual countries must be responsible for providing for the desirable amount of education in statistics. The United Nations could, however, facilitate the development of education in statistics in suitably equipped universities and institutes by arranging for limited subsidies for such purposes as research grants, endowed chairs of statistics, and scholarships. It could also assist by providing visiting lecturers and could encourage and facilitate international meetings of statisticians at which the most recent developments in statistical methodology could be discussed.

67. As regards practical training in the application of statistical methods, it was agreed that it would be appropriate for the United Nations to initiate and assist in financing short special purpose courses directed toward specific statistical undertakings. Examples of this kind of training can be found in the training institutes sponsored by the Food and Agriculture Organization—assisted in one instance by the United Nations—in connexion

with the 1950 World Census of Agriculture. Other such training schools could deal with national income techniques, crop estimating, and similar technical problems. In addition, the United Nations could foster improved training in statistics by bringing statisticians from different countries to the Statistical Office of the United Nations to participate in the normal operations of the Office or to undertake special investigations of technical problems under the direction of experts in particular fields.

68. Special attention was drawn to the desirability of seeking the active participation of leading professional organizations in further study of the problem of statistical education and training. These organizations include, among others, the International Statistical Institute, the Inter-American Statistical Institute, the Biometric Society and the Econometric Society. Several are in a position to advise upon technical aspects of statistical education and training, and it was suggested that the United Nations might wish to request the appropriate international organizations to give the entire question further study, particularly the needs for education and training, and the ways in which a wider use of statistical techniques might be fostered.

69. In this connexion, the Sub-Commission recommended that students following a course of statistical studies should receive a reasonably advanced education in sampling methods. The Sub-Commission agreed that members would co-operate in the preparation of a syllabus to be transmitted to the Secretariat. The syllabus would define the courses which, in the judgment of the members of the Sub-Commission, would constitute reasonably advanced education in the theory and applications of sampling.

CHAPTER XI

Programme of future work of the sub-commission

70. Many of the items considered at the first and second sessions of the Sub-Commission on Statistical Sampling represent a part of the continuing programme of the Sub-Commission relating to the improvement of methodology in statistical sampling. Among these are:

a) development of standard terminology in sampling;

b) examination of current sample surveys.

The procedures of reporting sampling surveys outlined in the second session will provide a basis for this analysis.

71. The world census programmes of agriculture and population that are being developed provide a series of problems in sampling. The Statistical Commission has requested that attention be given to the use of sampling in the tabulation and processing of data, and the application of sampling to obtain information supplementary to that collected by complete enumeration. The Commission also requested that study be given to the use of sampling methods to take the place of a complete count when the latter is impracticable.

72. In addition to these general responsibilities the Sub-Commission on Statistical Sampling has requested additional materials be prepared so that it may consider sampling problems involved in:

a) crop estimates and forecasting;

b) the development of basic statistics for national income compilations;

c) statistics for planning in economic development programmes;

d) statistical quality control.

CHAPTER XII

TIME AND PLACE OF THE THIRD SESSION OF THE SUB-COMMISSION ON STATISTICAL SAMPLING

73. The Sub-Commission was informed of the decision of the Economic and Social Council (E/1000/Rev.1) that the date and place of the third session of the Sub-Commission on Statistical Sampling is 5-16 September, 1949, at Lake Success. The Chairman pointed out that, unlike representatives in many of the United Nations Commission, the members of the Sub-Commission on Statistical Sampling were not representing national governments, but were serving as technical experts in their individual capacities. No question of attendance of alternate members could therefore be raised, and in view of this fact the members of the Sub-Commission would request the Secretariat to arrange the sessions in such a manner as to fit in with their now existing commitments. The present session had been arranged on the basis of such considerations.

74. Moreover, the biennial conference of the International Statistical Institute has been set for 1-11 September 1949 in Switzerland; the International Biometric Society will meet immediately before that session. The members of the Sub-Commission were of the unanimous opinion that it would be essential that the third session of the Sub-Commission should meet in Geneva immediately after the international Statistical Institute session. This would permit the attendance and participation of a large number of eminent statisticians at the third session of the Sub-Commission.

75. In view of these considerations, the Sub-Commission unanimously requested the Secretariat to arrange the meeting of the third session of the Sub-Commission on Statistical Sampling in Geneva at a suitable date in September 1949.

UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL

SUB-COMMISSION ON STATISTICAL SAMPLING

REPORT TO THE STATISTICAL COMMISSION ON THE SECOND SESSION OF THE SUB-COMMISSION ON STATISTICAL SAMPLING

RECOMMENDATIONS CONCERNING THE PREPARATION OF REPORTS OF SAMPLING SURVEYS

These recommendations have been prepared by the Sub-Commission on Statistical Sampling in the hope that they will be of assistance to those engaged in the preparation of reports of sampling surveys. They necessarily involve technical terminology, the use of which will foster clarity, comprehensiveness, and international comparability in reports that deal with aims, methods used, and accuracy attained. Information supplied on the lines suggested will enable those making use of the report to utilize the results obtained to full advantage, to assess for themselves the reliability of those results and to utilize the experience gained in the conduct of the survey in planning future surveys on similar material. The recommendations are not intended to be final but are to be regarded as an outline of the various points which require description and analysis in the application of sampling methods in censuses and surveys. Comments should be addressed to the Statistical Office United Nations, Lake Success, N.Y., U.S.A.

1. General description of the survey

The general description of the survey should include information on the following points. Some of these will require fuller treatment in the more detailed technical sections of the report.

a) *Statement of purposes of the survey*: A general indication should be given of the purposes of the survey and the ways in which it had been expected that the results would be utilized.

b) *Description of the material covered*: An exact description should be given of the geographical region and the categories of material covered by the survey. In a survey of a human population, for example, it is necessary to specify whether such categories as hotel residents, institutions, (*e.g.* boarding houses, sanatoriums), vagrants, military personnel, were included. The reporter should guard against any possible misapprehension regarding the coverage of the survey.

c) *Nature of the information collected*: This should be reported in considerable detail, including a statement of items of information collected but not reported on. The inclusion of copies of the schedules and relevant parts of the instruction used in the survey (including special rules for coding and classifying) is often of value. If this is impracticable, it may be possible to make available a limited number of copies which may be obtained on request.

d) *Method of collecting the data*: Whether by interviewers, investigators, mail, etc.

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e) *Sampling method*: An indication should be given in general terms of the type of sampling adopted, the size of the sample, the proportion it forms of the material covered, and arrangements for follow-ups, if any, in cases of non-response.

f) *Accuracy*: A general indication of the accuracy attained should be given.

g) *Repetition*: State whether the survey is an isolated one undertaken without intention of repetition, or is one of a series of similar surveys.

h) *Point or period*: Point or period of time to which the data refer.

i) *Date and duration*: The starting date and period taken for the field work.

j) *Cost*: An indication should be given of the cost of the survey, under such headings as preliminary work, field investigations, analysis, etc.

k) *Responsibility*: The name of the organization sponsoring the survey and of the one responsible for conducting it.

l) *References*: References should be given to any published reports or papers.

2. Design of the survey

The design of the survey should be carefully specified. The following terms are believed to cover the main types of design and to conform in the main with current terminology in so far as this has been established:

a) *Frame*: The frame or "substrate" consists of previously available description of the material in the form of maps, lists, directories, etc., from which sample-units may be constructed and a set of units selected. The specification of the frame should define the geographical scope of the survey and the categories of material covered; also the date and source of the frame. Frames that are initially available often require emendation, particularly in the later stages of multi-stage sampling, before they may be considered adequate: at times a frame may need to be constructed *ab initio*. In such cases the method of emendation or construction should be described.

b) *Physical units*: Those units which are not subdivided for the purposes of the survey.

c) *Sample-units*: The units which form the basis of the sampling process. The sample-units may be (i) the same as the physical units or (ii) may be groups of such units. A group may consist of a cluster of contiguous physical units, or a number of physical units arranged in an assigned configuration. A systematic pattern of physical units may, for instance, constitute a sample-unit.

It is conceptually convenient that the sample-units be so defined that the totality of sample-units contains every physical unit once and once only.

It is important to specify the quantitative and qualitative characteristics of the sample-units which have been recorded in the enquiry, as these form the basis of all subsequent analysis, and in the cases of multi-stage and multi-phase sampling, may also have been used in determining the sampling procedure.

d) *The sample*: The aggregate of the sample-units selected constitutes the sample. A sample supplies both objective estimates (of means, totals, etc.) and information for estimating their precision. The word sample may be used either for the aggregate of sample-units chosen from a single stratum, or in a wider sense, for the whole of the sample.

units chosen in a complete enquiry. In the first sense the sample is usually a specified fraction of the stratum it represents.

e) *Domain of study* : Any sub-division about which the enquiry is planned to supply numerical information of known precision may be termed a domain of study. It is desirable to indicate the smallest domains of study about which the enquiry may be expected to provide information of adequate accuracy.

f) *Block of domains* : A group of two or more domains of study, contrasts between which it is required to evaluate, may be termed a block of domains.

g) *Field of enquiry* : The entire field of an enquiry is coextensive with the frame used as its basis, and will often consist of a number of blocks of domains.

h) *Stratification* : The totality of sample-units may be divided into groups or "strata," each stratum being sampled separately so that a specified number of sample-units is obtained from each stratum. Such strata may be geographic subdivisions, divisions depending on some quantitative or qualitative variate appertaining to the sample-units, etc.

i) *Uniform and variable sampling fractions* : The numbers of sample-units specified may be such that from each stratum the same fraction of units is selected, in which case the term stratification with uniform sampling fraction, or proportionate sampling, is used; or the numbers specified may be such that different fractions of the different strata are selected, in which case the term stratification with variable sampling fraction is used.

j) *Multiple stratification* : In certain cases the totality of sample-units may be divided simultaneously according to two or more classifications, each of which depends on one geographic, quantitative, or qualitative variate. Each cell determined by the two or more way classification itself potentially constitutes a stratum of the totality of sample-units. If each of the cells is sampled separately, as in an ordinary stratified sample, the term multiple stratification may be used without qualification. If the available information is not adequate for this to be done, so that the numbers of sample-units in the main strata only can be pre-determined, this is termed multiple stratification without control of sub-strata.

k) *Multi-stage sampling* : In multi-stage sampling the material is regarded as made up of a number of first-stage sample-units, each of which is made up of second-stage units, and so on.

There is thus a hierarchy of different types of sample-units, each first-stage unit being divided (or potentially divisible) into second-stage units, etc. At the first stage of sampling, a number of first-stage units are selected; from each of the selected first-stage units, a number of second-stage units are then selected and so on.

For example, a country may be considered as divided into a number of districts, each district into a number of villages; each village into a number of farms. In multi-stage sampling a number of districts is selected in the first stage; within each such selected district a number of villages is selected in the second stage, and from each selected village a number of farms is selected at the third stage for enquiry. In the case of a crop-cutting investigation, the work may be carried further by the selection of fields from each selected farm and by plots within a field.

In multi-stage sampling a frame will be required at each stage for the units that have been selected at that stage. Initially, a frame is required by which first-stage units may be defined and selected. For the second stage of selection, a frame is required by

which second-stage units may be defined within the first-stage units which have been selected. One of the advantages of multi-stage sampling is that second stage frames are only required for selected first-stage units and so on.

l) *Multi-phase sampling*: It is sometimes convenient and economical to collect certain items of information on the whole of the units of a sample, and other items of information on some only of these units, these latter units being so chosen as to constitute a sub-sample of the units of the original sample. This may be termed two-phase sampling. Information collected at the second or sub-sampling phase may be collected at a later time, and in this event, information obtained on all the units of the first-phase sample may be utilized, if this appears advantageous, in the selection of the second-phase sample. Further phases may be added as required.

An important application of multi-phase sampling is the use of the information obtained at the first phase as supplementary information to provide more accurate estimates (by the method of regression or ratios), of the means, totals, etc., of variates obtained only in the second phase.

Information obtained in a complete census may be used in this manner to improve the estimates obtained from a sample, in which case the complete census and sample are analogous to the first and second phase sample respectively.

Multi-phase sampling may be combined with multi-stage sampling. For example, in a nutrition survey in which an exact record of the food consumption of individuals is required, and the method of "weighings" is adopted, i.e. the quantities of the various food consumed are actually weighed, the amount of labour in which the housewife is involved is so great that it has been found impracticable for records to be collected for more than one member of a household. On the other hand, information on economic status, expenditure on food, etc,. must be collected for the household as a whole. A sample of households may therefore be taken on which the economic data are collected (first-phase, first-stage). A second stage ample of one individual from each selected household may then be taken for the determination of food consumption (second-stage, second-phase). The two phases then provide relationships between consumption and economic status. A modification which gives greater relative accuracy for the first-phase information is to take a larger sample of households for the collection of economic data, and to select a sub-sample of these households for the determination for food consumption, one individual being taken from each of the selected households as before.

m) *Interpenetrating (networks of) samples*: Whatever be the method of choosing the sample-units (with or without stratification; single or multi-stage; single or multi-phase), it is possible if desired to arrange the sample units in sets of two or more interpenetrating (networks of) samples within each domain of study, and to collect the information for each such sample in an independent manner so that each sample would supply an independent estimate of the variates under study. In such cases the interpenetrating samples may be regarded as analogues of plots in the theory of design of experiments, and an analysis of variance can be carried out in the usual way. Another term for this procedure is replicated sampling.

Interpenetrating samples can be used to secure information on non-sampling errors such as differences arising from differential interviewer bias, different methods of eliciting information etc.

The interpenetrating network therefore provides a means of control (i.e. appraisal) of the quality of the information. For example, in a family budget enquiry, in each domain of study the sample units may be chosen in the form of two or more independent sets each of which covers the whole domain, and the information for every such set may be collected by a different investigator. In this way, an independent estimate for the whole domain would be obtained based on the material collected by each investigator, and a comparison of such independent estimates (by analysis of variance) would show whether there were significant differences between different investigators which may often indicate appropriate action for improving the planning of similar surveys in the future.

n) *Composite sampling schemes* : There are occasions on which different methods of sampling are required for different parts of the material. In sampling a human population, for instance, some form of sampling of areas (in which the sample-unit is a small area) may be most suitable for the rural parts of the country whereas some form of sampling based on lists of households may be best in the towns. This may be termed a composite sampling scheme.

o) *Successive (or repeated) surveys* : Sometimes a sample survey of the same kind is repeated at suitable intervals to constitute a series of successive surveys. In such cases it is possible to choose entirely independent sample-units in each survey, or to keep a certain number (or a certain proportion) of sample-units the same in two or more surveys. This latter procedure is particularly useful for the study of changes. The continuing operation of a survey agency on successive surveys of the same type usually also leads to a gradual improvement in the quality of the information.

p) *Pilot and exploratory surveys* : In undertaking large scale surveys, particularly of unexplored material, it is usually advisable to conduct pilot and exploratory surveys to test and improve field procedure, and schedules, and to train field workers; at the same time to obtain information which will enable the sample-design to be planned more efficiently, and to obtain an estimate of the cost. For example, the results of a pilot survey may be used to estimate the first and second stage components of variance relevant to some two-stage sampling process which is envisaged for the main survey and also the relevant components of cost, from which it is possible to determine the optimum intensity of sampling at each of the two stages.

3. METHOD OF SELECTING SAMPLE-UNITS

A process is properly described as random if to each unit has been initially assigned an independent and determinate probability of being selected. One expeditious way of effecting a random selection is by the use of random sampling numbers; equally, with more labour, this may be done by any of the apparatus used in games of chance. Systematic selection is often used when the person responsible for the planning of the survey is satisfied that it is in practice equivalent to a random selection in the respects required. In such cases he accepts personal responsibility for the judgment on which his plan is based.

The reporter should describe the procedure used in selecting sample-units, and if this not a random selection he should indicate the evidence on which he relies for adopting an alternative procedure. Purposive selection and quota sampling cannot be regarded as equivalent to random sampling.

4. Personnel and equipment

It is desirable to give an account of the organization of the personnel employed in collecting, processing and tabulating the primary data, together with information regarding their previous training and experience. Arrangements for training, inspection, supervision, and methods of processing data should be explained as also should methods of checking the accuracy both of the primary data and of the processing. A brief mention may be made of the equipment used in processing the data.

The critical observations of the technicians in regard to any part of the survey should be given. These observations will help others to improve their operation.

5. Costs

An important reason for the use of sampling (instead of complete enumeration) is lower cost. Information on costs is therefore of great interest. Costs should be classified so far as possible under such heads as preparation (showing separately the cost of pilot studies), field work, supervision, processing, analysis, and overhead costs. In addition, labour costs in man-weeks of different grades of staff, and also time required for interview and journey time and transport costs between interviews, should be given. The compilation of such information, although often inconvenient is usually worth undertaking as it may suggest substantive economies in the planning of future surveys. Efficient design demands a knowledge of the various components of cost as well as of the components of variance.

6. Accuracy of the survey

a) *Precision as indicated by the random sampling errors deducible from the survey* : Standard deviations of sampling-units should be given in addition to such standard errors (of means, totals, etc.) as are of interest. The process of deducing these estimates of error should be made entirely clear. This process will depend intimately on the design of the sample survey. An analysis of the variances of the sampling-units into such components as appears to be of interest for the planning of future surveys is also of great value.

b) *Degree of agreement observed between independent investigators covering the same material* : Such comparison will be possible only when interpenetrating samples have been used, or checks have been imposed on part of the survey. It is only by these means that the survey can provide an objective test of possible personal equations (differential bias among the investigators).

c) *Other non-sampling errors* : (i) Errors which are common to all investigators, and indeed any constant component of error (or "bias") in the recorded information, will not be included in the estimates of the random sampling errors deducible from the survey results. (ii) Another source of error of the same type is that due to observation of the quantities which do not correspond exactly to the quantities of which estimates are required : in a crop cutting survey, for example, the yields of the sample plots give estimates of the amount of grain etc. in the standing crop, whereas the final yield will be affected by losses at harvest. (iii) The possible effects of such errors on the accuracy of the results, and of incompleteness in the recorded information (e.g., non-response, lack of records, whether covering the whole of the survey or particular areas or categories of the

material), should therefore be fully discussed. (iv) Any special checks instituted to control and determine the magnitude of these errors should be described, and the results reported.

d) *Accuracy, completeness and adequacy of the frame* : The accuracy of the frame can and should be checked and corrected automatically in the course of the enquiry, and such checks afford useful guidance for the future. Its completeness and adequacy cannot be judged by internal evidence alone. Thus complete omission of a geographic region or the complete or partial omission of any particular class of the material intended to be covered cannot be discovered by the enquiry itself and auxiliary investigations have often to be made. These should be put on record, indicating the extent of inaccuracy which may be ascribable to such defects.

e) *Comparison with other sources of information* : Every reasonable effort should be made to provide outside comparisons with other sources of information. Such comparisons should be reported along with the other results, and the significant differences should be discussed. The object of this is not to throw light on the sampling error, since a well designed survey provides adequate internal estimates of such errors, but rather to gain knowledge of biases, and other non-random errors.

f) *Efficiency* : The results of a survey often provide information which enables investigations to be made on the efficiency of the sampling designs, in relation to other sampling designs which might have been used in the survey. The results of any such investigations should be reported. To be fully relevant the relative costs of the different sampling methods must be taken into account when assessing the relative efficiency of different designs and intensities of sampling.

Such an investigation can be extended to consideration of the relation between the cost of carrying out surveys of different levels of accuracy and the losses resulting from errors in the estimates provided. This provides a basis for determining whether the survey was fully adequate for its purpose, or whether future surveys should be planned to give results of higher or lower accuracy.

COMPARABILITY OF MEASUREMENTS

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In the study of racial types, measurements taken by different observers have often to be compared. The adoption of standard instruments and of the anatomical land marks agreed upon at Monaco, in conjunction with the detailed guidance given in Martin's classical work (Martin, 1928) have helped to render observations comparable when taken by different persons.

Nevertheless the technique of measurement followed by different observers still leaves a certain amount of vagueness regarding the actual statistics collected. Even if this defect is eliminated, another important question remains to be solved. When two series of observations are compared, and the difference between means is analysed, we have to decide how far such difference represents a real difference between the samples of the populations, for which the means have been noted. We expect some difference in two samples drawn from even the same population, as there will be some variation due to errors of random selection. But it is necessary to ascertain, what variations are introduced by the personal factor of the observer.

The range of such variations and percentage of inaccuracy in measurements caused by the personal factors can be ascertained by having the sames series of subjects measured by different observers independently. Such an investigation was taken up by three observers among us some years ago Two of the men were members of the staff of the Department of Anthropology, University of Calcutta and the third a student who had obtained his M.Sc. degree in this subject from the same University a year earlier. Originally it had been planned to measure a hundred individuals for stature, head length, head breadth, head height, nasal height, nasal width, bizygomatic breadth, bigonial breadth, and total facial height. Unfortunately after fifty individuals had been measured with regard to stature, head length, head breadth and head height, the team broke up. The measurements are, however, of sufficient importance to justify a short note based on the statistics collected.

Head length was measured with the standard spreading Callipers (Tasterzirkel) from glabella to opisthocranion in the median sagittal plane, and checked by locking the indicator by the screw provided for this purpose and moving the rear terminal up and down. Head breadth was measured from euryon to euryon behind and above the ears and afterwards checking as for he- length, by locking the screw. The movement of the compass points was in thi' case over a small area close to the euryon, keeping the line joining the compass points at right angles to the median sagittal plane.