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CPH/INF/4

9 August 1974

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ECONOMIC COMMISSION FOR AFRICA

Meeting of African Census Programme Country Experts

Addis Ababa, 19-23 August 1974

Fourth Meeting of the Consultative Group on the

African Census Programme

Addis Ababa, 28-30 August 1974

TECHNICAL AND ORGANIZATIONAL PROBLEMS OF THE
AFRICAN CENSUS PROGRAMMETable of contents

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I. INTRODUCTION

This document presents the principle technical and organizational problems that have been encountered in the development and implementation of the African Census Programme. It was compiled by the Chief of the Statistics Division, ECA, and his staff of African Census Programme Regional Advisers. This paper includes expositions of varying lengths on the items listed in the table of contents. In addition to discussing the African Census Programme's principle technical and organizational problems, each section can be utilized as to guide for national census organizations and/or UN census experts to resolve some of the problems that have been encountered in the planning, implementation and conduct of national census programmes in their respective countries.

Distribution of this document does not imply that its contents have been approved by any official agency of the United Nations. The Statistical Division, ECA, would welcome any comments on any of the items discussed in this document.

II. SCOPE OF THE CENSUSES AND TOPICS

1. The African Census Programme was established early in 1971 with the purpose of formulating a comprehensive programme of assistance for the collection, tabulation, publication and analysis of population data. Technical and financial assistance would be granted to those ECA member States which requested technical and/or financial assistance from the United Nations Fund for Population Activities.

2. The general plan adopted by most of the 22 ECA member States participating in the African Census Programme includes a complete count of the population, household by household, with minimal subject coverage, plus a sample survey for the collection of detailed population characteristics. In some cases the sample survey will be conducted simultaneously with the 100% operation by using an expanded questionnaire for selected enumeration areas. In other countries the sample survey will be conducted at a later stage by re-enumerating selected areas using an expanded questionnaire. Usually, the expanded or long questionnaire includes questions on fertility, mortality and migration.

3. The topics recommended for investigation in population censuses of the 22 ECA member States participating in the African Census Programme were chosen primarily on the grounds of national needs. They largely reflect past experience with methods and definitions formulated to produce the data required for development planning and for demographic research. The topics are as follows:

a) Minimum list of topics recommended for inclusion in the "African Recommendations"

- 1) Name
- 2) Place where found at the time of enumeration
- 3) Place of birth
- 4) Sex
- 5) Age
- 6) Children born alive
- 7) Children living
- 8) Live births in the past 12 months (by sex)^{a/}
- 9) Deaths in the past 12 months (by sex and age)^{a/}

^{a/} Considered other useful topics in the "African Recommendations".

b) Additional list of topics recommended for inclusion
in the "African Recommendations"

1) First priority

- a) Type of economic activity
- b) Occupation
- c) Educational attainment
- d) Marital status

2) Second priority

- a) Relationship to head of household
- b) Ethnic group or citizenship
- c) Literacy
- d) School attendance
- e) Industry
- f) Status (employer, employee, etc.)
- g) Usual place of residence
- h) Duration of residence
- i) Previous place of residence
- j) Religion a/
- k) Number of wives a/
- l) Number of years since first marriage a/
- m) Children below school age a/
- n) Worked any time in the past 12 months a/

The content of the final census questionnaire is usually determined after the analysis of the pilot census results. In some countries, the final questionnaire topics have limited to the minimum list of topics plus the first priority topics from the additional list of topics recommended for inclusion in the "African Recommendations". The decision to limit the scope of the census questionnaire was made to decrease the enumerator workload and thereby lessening the chances of jeopardizing the accuracy of the total count.

III A. CENSUS CALENDAR, PLANNING AND ORGANIZATIONAL RESPONSIBILITY IN THE DIFFERENT CENSUS PHASES

Introduction

1. The concepts of calendar, planning and organization can be said not only basic to the census project, but also to have an overriding importance at every phase of the census implementation programme and every step within each phase. The failure for having recognized this fact may explain some of the difficulties experienced by many countries participating in the African Census Programme, while a failure for correcting this lack may make the difference between a good census, a bad census or no census at all.

2. It should first of all be noticed that the concepts of calendar, planning and organization though referring to distinct and specific operations, are highly complimentary of one another. The census calendar is, indeed, but an ordered and systematic transcription of the planning that has been foreseen for its implementation. This planning, on the other hand, is directly contingent on the organization that has or will be created to carry it out.

3. Up to a point, it can be said that the quality and competence of the census organization of a country determine the quality and realism of the planning. The latter, in turn, allows the preparation of a census calendar that thereafter acts as a guide line and control mechanism over the entire implementation of the project.

4. One should not lose track of the fact that while a census is theoretically a simple concept to grasp, its implementation can be classified among the most complex statistical operations. It can be compared to a vast plan of action that requires bringing together over space and in a synchronized arrangement a broad and diversified range of expertise and activities that will involve thousands of people. The issue of such an undertaking definitely rests on its planning and related calendar both of which are contingent on the existence of an adequate organization.

5. The present subject will be analysed, under the headings of:

- I. The Initial Census Calendar
- II. The Legal Basic of a National Census
- III. The Census Central Organization
- IV. The Census Calendar

I. THE INITIAL CENSUS CALENDAR

6. It must be accepted as a fact that for most countries the initial census calendar is the basis on which the enumeration dates were first established, and against which postponements are to be measured, related to the one found in the project request for financial assistance. A work plan was indeed required when submitting a request to UNEFPA indicating the starting point and duration of each operation entering into the implementation of the project (UNEPFA 19, Annex III - Work Plan).

7. This initial calendar can at the most be considered as a budgetary calendar and not one truly effectively depicting the census implementation programme. It was a requirement in order to give both the local governments and UNEFA an idea of magnitude of the operations to be performed, the expertise and resources required, the equipment and supplies to be purchased and the financial support to be acquired. It is the basis of the project request and related preliminary calendar and its related work plan that funds could be approved, released and the operation initiated.

8. The major draw back faced by most countries dealt initially with the 14 months it took the UN on an average for approving funds and for recruiting census country experts*. Other delays were also experienced in relation to the purchase and delivery of supplies, such as office furniture, vehicles, paper, printing equipment, etc.. On the basis of these observations alone, one can logically conclude that the initial census target dates could not be met.

9. It must, nevertheless, be noted that the resolution of the above mentioned problems, as is presently the case for most countries, is not in itself a guarantee of success, for the new census dates, which would now be in the 1975-76 realm. These new dates, indeed, are a direct result of what can be called a re-basing of the initial calendar in order to take into account the numerous delays mentioned previously. They may consequently be thought to be realistic in relation to the calendar on which they were based is comprehensive and realistic. There are reasons to believe that in some instances this may not be the case and that, consequently, other types of difficulties can be expected with concurrent postponements, unless review and correction of the census calendar is immediately brought forward.

II. THE LEGAL BASE OF A NATIONAL CENSUS

10. The legal base of a national census may be considered as a prerequisite to a census and consequently outside the actual planning activities. It is nevertheless the first item that generally appears on the list of elements entering into a census. In the Report of the Seminar on Organization and Conduct of Censuses of Population and Housing, held in Addis Ababa in June 1968, one can read, under the chapter of "General Census Planning, that:

11. "The preparation of the legal base for the census was considered a very important basic element of a census plan. It was agreed that without such legal authority clearly defined no step could or should be taken because it was only by virtue of this authority that the funds could legally be appropriated for the carrying out the census and administrative responsibility fixed".**

* Report on the ACP presented to the Fourth Regional Inter Agency Co-ordination meeting on Population; Addis Ababa, July 1974.

** Report on the Seminar on the Organization and Conduct of Censuses of Population and Housing - Addis Ababa - 17-20 June 1968 - Vol. 1 page 4

12. It would seem that this recommendation has been somewhat forgotten in the case of some countries and that its actual relevance, as relates to the planning of a census was not always fully appreciated. If looked at from the planning and the calendar point of view, a legal base is required from the start in order to set up the administrative bodies that will have the responsibility to determine the scope of the census and the nature of the political and financial commitment required by the country.

13. In brief, a realistic drafting of a census calendar, and related budget, call for the prior existence of:

- a) a national commission or committee on census with the responsibility to develop an acceptable census programme;
- b) a national central census office with the primary responsibility to prepare a detailed census programme including the information to be solicited, the query model to be used, the operations to be performed, the timing of these operations, the equipment that will be required and the human and financial resources that will be needed.

14. It is on the basis of the work of the central census organization that the census calendar is in fact set up, and that the government, through the national commission on census, can properly appreciate the extent of its commitment to the operation and the external support that will be required in one form or another.

15. It may finally be noted that while the national commission on census may have to be created first, in order to establish the central census organization, the existence of the latter is thereafter essential in order for the commission to deliberate on census matters.

III. THE CENTRAL CENSUS ORGANIZATION

16. The question of the organization of the central census office will be looked into in the following paper. The intent of the present chapter is to point out that until such time this office is organized and adequately staffed not only is it difficult to prepare a valid census calendar but even more to engage in the implementation of the census. One can in fact say that the census operation has truly started only when this central office has been created.

17. There is general agreement in the literature dealing with the matter, in recognizing some seven main functions in the composition of the census central office*. These may vary in name and content depending on the countries but generally correspond to the following main activities:

- a) cartography, for setting the census geographical frame;
- b) demography and statistics, for defining the content and query model of the census operation;
- c) data processing, for deciding on the data capture, storage and retrieval
- d) administration, for assuring a systematic control over all activities that enter into a census and that call for extensive hiring of census personnel and supervision of material and equipment;

* Report on the Seminar - Vol II, Part I page 19, paragraph 55

- e) accounting, for an effective budgeting of the operation and disbursement of funds over time and space, as also for the purchase and maintenance of equipment and payment of salaries;
- f) operation, for laying out the plan by means of which the high volume of personnel and documents can be handled effectively over space and in a timely fashion;
- g) communication and information for resolving the problems that are related not only to publicity but also to the preparation of manuals and other documents required for training, which is an important factor in the implementation of a census.

18. The point to be made is that these functions have to be adequately represented at the planning stage of a census. Failure in this respect can result in omissions or miscalculations that can impair the entire operation and create difficulties over and above those that are normal for an undertaking of this magnitude.

19. It is fully recognized that in developing countries very few national statistical offices can readily supply the census with the range of senior professionals required to plan and implement the census operation. This situation has been met in some countries by drawing heavily on the statistical office senior staff and/or counting on graduates of various schools expected to end their formal training in time to be utilized in the census operations.

20. Neither of these solutions can be said to be satisfactory. The national central statistical office on one hand, does not generally have the full scale of professionals needed to plan and carry out a census, and, on the other hand, this practice can dangerously impair the conduct of other statistical operations that still have to be carried out in the course of the two to three years needed to prepare for and conduct a census. Newly trained professionals lack of practical experience while the conduct of census is quite demanding in this respect.

21. It should be remembered that not only is census a national undertaking but also one that calls for a broad range of expertise, statistics and demography being only two of those required. The other senior professionals can often be found more efficiently in other departments. The fact of having or not having recourse to this expertise depends on the level of priority a government attaches to the census operation relation to other projects.

22. In many countries, indeed, the census cartography can more efficiently be carried out by a geographic work unit that operates in departments such as those of agriculture or natural resources. In the same fashion data processing can be provided by the central data processing service. The expertise required to deal with the managerial and accounting components of the census, which are in fact quite substantial and crucial, can often best be carried out by seconding senior officers that have acquired experience with the department of finance or public works. The field work and training components related to census could benefit from the experience of senior officers that have worked in departments such as those of education, communication and information.

23. The point to be brought out here is that a census expert is basically one who brings in his competence to the implementation of census. Census is not a field of science such as cartography, statistics, demography, etc. In a sense there is no census expert but more rightfully a gamut of various experts that apply their knowledge to the operation called census.

IV. THE CENSUS CALENDAR

24. Paragraph 50 page 25 of the second volume part I of the Report on the Seminar on the Organization and Conduct of a Census, makes reference to at least two different census calendars, that is:

"The first one has to be prepared during the first phase of the preparation, together with the general programme. The second, final and detailed calendar has to be prepared after the development of the census programme and census organization."

25. The first of these calendars corresponds to the work plan of the initial project request analysed in the first section of this paper. It deals with the general outline of the census operation and is initially needed for preparing evaluations of resources and cost estimates. The latter, on the other hand, relates directly to the actual planning of the census and can be designated as the calendar of operations. It corresponds to the first true census operation and can only be produced once a central organization has been created and staffed with the required senior professionals.

26. The final census calendar indeed, is the detailed census programme prepared in such a way "as to reveal the relationship of each element to the other elements in a time sequence as well as the minimum amount of time needed to complete that particular operation and the latest date at which it should be finished in order not to interfere with the activities of other operations."*

27. If analysed closely we can immediately see that according to this statement the census calendar, the basis on which the implementation is to be carried out and controlled, is an exacting operation that may well require some two to four months of continuous work to produce. Two basic conditions are required for the preparation of the census calendar.

- a) The clear identification of each of the main functions that have to be performed in order to carry out the operation over the two to three years it will take to implement the census.
- b) The designation of the census senior officers to be accountable for the implementation of each of the main functions.

28. In brief, a census calendar cannot be prepared in isolation or by a team of experts that are not subsequently accountable for the conduct of the operation. UN census country experts in this instant can advise on the preparation of the calendar but cannot make final decisions.

* Report on the Seminar Vol. I paragraph 19.

29. The census calendar generally includes three phases though these may not, in practice, be fully separated.

- a) In the first instance each officer accountable for one of the main functions must prepare that part of the census calendar which is related to his responsibility. One can consequently think in terms of a "cartography calendar" a "demography calendar," a training calendar," a "data processing calendar," etc.
- b) The series of individual calendars must subsequently be combined into a general census calendar that take into account the inter-relationships of the various operations over space and time.
- c) This latter general calendar must finally incorporate the various administrative, financial and operational functions that are integral parts of a census. These refer specifically to the purchase of supplies and equipment, the hiring of and payment to enumerators, the printing of documents, accommodations for training the shipment of questionnaires and other documents from and to the central office, etc..

30. Such a census calendar can only be prepared by a central census team working in very close cooperation. The complexity of the calendar and time required for preparing it, will be directly proportionate to the scope of the census operation to be carried out.

31. The importance of this final calendar cannot be exaggerated and the implementation of the census programme should not be initiated until it has been completed. It is indeed on the basis of this calendar that:

- a) The initial census project request can be appraised more realistically and corrected accordingly.
- b) The local government can be better informed as to the true magnitude of the operation, and consequently reaffirm its intention for proceeding with it and for committing the various professional and financial resources that will be required, or if applies, reduce its scope to conform with its capabilities.
- c) The various census specialists can make known their requirements as related to other elements of the census model, such as the relationships of data processing with the content, coding and format of the census questionnaire, that of the cartography element as it relates to sampling etc.

CONCLUSION

32. In brief, a census calendar is the census in perspective. It takes into account the plan by means of which each operation is to be implemented in relation to the series of operations included in the entire project. This plan, in turn, must be in accordance with the organization that is to be accountable for its implementation. The creation and staffing of this organization, in order to be effective, calls for some legal recognition by the country engaged in the census project.

33. It has been found that many countries have not yet produced their final census calendar. These countries, as a rule, have been quite late in defining the census legal base and related central census organization. Some census operations have, nevertheless been underway for sometime in various countries, such as cartography, the census questionnaire, sampling design or planning in data processing. The true nature and cause of the delay and difficulties experienced by these countries cannot, on the other hand, properly be evaluated

and corrected without the existence of a true census calendar. Delays attributed to the UN resulting from the time (lag) in approving the project request, the recruitment of country experts and delivery of supplies, though important may still not be the most significant cause for postponement of the operation. These events, however regretful, can indeed better be coped with the compensated for when a central census organization and related census calendar exist.

III B. ORGANIZATION OF A NATIONAL CENSUS OFFICE

I. INTRODUCTION

1. According to the Principles and Recommendations for the 1970 Population Census; "The population census is one of the most extensive and complicated statistical operations, consisting of a complex services of closely interrelated steps which must be carefully planned in advance so that a proper and uninterrupted sequence of operations can be maintained. A small oversight in planning may lead to serious defects and inefficiencies. Careful planning is, therefore, of the first importance to the successful conduct of the operation, not only in countries with comparatively little statistical experience but also in countries with a developed system of statistics." (para. 39)
2. If the census operation is to be properly planned and executed, preparations should start from two to three years before the actual enumeration begins. The size and structure of the national census office depend on (i) the system of public administration in the country; (ii) the level of the development of the national statistical service; (iii) the size of the population to be counted; (v) whether a census tradition exists; (vi) the type of census to be conducted and (vii) the financial, physical and human resources that are available for the conduct of the census.
3. There are two types of national census organizations. They are:
 - a) A permanent census office that has continuous responsibility for census work within the national statistical service.
 - b) An ad hoc census office that is created before beginning preparation for each national census and that is dissolved after the census operations end.

Since, the most prevalent type of census organization in Africa is the ad hoc organization, this paper will confine itself to the ad hoc organization.

II. PRINCIPLES OF A CENSUS ORGANIZATION

4. The special organizational requirements arising from the fact that a population census is an ad hoc statistical operation, it is preferable to have or establish an independent organization for its planning, preparation and execution. This independent organization should be an integral part of the national statistical service. Its composition and size will change as required, with the different phases of the operations. It will reach its greatest size in the enumeration phase. It will be relatively small in size during the pre-enumeration and post-enumeration phases.
5. According to the Principles and Recommendations for the 1970 Censuses, the preparatory phase includes the following elements:
 - a) Legal basis for a census;
 - b) Budget and cost control;
 - c) Census calendar;
 - d) Administrative organization;
 - e) Cartographic work;

- f) Living quarters and household listing;
- g) Tabulation programme;
- h) Questionnaire preparation;
- i) Census tests;
- j) Plans for enumeration;
- k) Plans for data processing;
- l) Publicity;
- m) Staff recruitment and training.

6. The elements listed in 5 above are not entirely separate chronologically or mutually exclusive. At various stages there is much overlapping, due to the fact that different types of work can be performed at the same time. The conduct of the census demands detailed, specialized and careful preparation so as to avoid the possibility of having to take piecemeal and improvised measures at various stages which might adversely affect the census results.

7. The national census organization is generally established on three levels:

- a) Preparation and execution of the census at the national level by the central census office;
- b) Preparation and execution of the census at the regional, provincial, and local levels, by census field offices;
- c) Co-ordination of the census work at the national and territorial levels, by the national, regional and local census commissions. The national census commission, the census head office, the regional census offices and subsidiaries (i.e. provincial, district and local field offices) and the field staff. This paper will confine itself to the organization, scope and functions of the national census commission and the census head office.

III. NATIONAL CENSUS COMMISSION

8. According to the Report of the Seminar on the Organization and Conduct of Censuses of Population and Housing, (vol. I, para. 41), "The utility of a national census committee was emphasized by the majority of the participants, who recognized the power of such a body to stimulate a national, co-ordinated effort to facilitate the census work. These committees, by virtue of their bringing together senior representatives of the government departments and non-governmental organizations who are consumers of the census data, have it in their power to give both psychological and material support to the census organization."

9. The census commission may include representatives of the following governmental bodies: Departments (or Ministries) of the Interior (or local government) Health, Education, Information, Agriculture, Housing, Justice, Defense, Labour, Transport and Communications, the national planning office, a representative from police, armed forces and the national cartographic (geographic or land surveys) institute, the director of the national statistical agency and the director of the central census office. Also, the commission may include representatives of private and semi-official organizations such as newspaper and magazine publishers, employer's associations, labour unions, research and universities.

10. Since the main function of the commission is advisory, it should meet only at periodic intervals. Its main work can be done by several sub-commissions or committees.

The report of the Seminar on the Organization and Conduct of Censuses of Population and Housing, (vol. II, part I, para. 86) states, "It is recommended that at least the following sub-commissions should be established:

- a) Programme sub-commission, which decided on the census topics, tabulations, questionnaires, etc., and in which representatives of users of the census data participate in an advisory capacity;
- b) Finance sub-commission, which works out the financial and personnel plans for the census;
- c) Field organization sub-commission, which co-ordinates the field organization, cartographic and geographic preparation of the census, etc. and on all with employees participating in the census enumeration are represented, (for instance, Departments of Interior, National Defence, Police, Health, Education, etc.);
- d) Publicity sub-commission, which helps in the preparation and execution of the publicity campaign to obtain the full co-operation of the population. In this sub-commission representatives of the radio, TV stations, the press, etc. participate also.

11. If properly utilized the census commission can significantly reduce the heavy workload of the census head office.

IV. ORGANIZATION OF THE CENSUS HEAD OFFICE

12. The census head office's principal tasks are as follows: (See Annex I for a suggested head office organizational chart.)

- a) to secure office space for the census headquarters;
- b) to develop the census plan and calendar for approval of the census commission;
- c) to execute the final census in accordance with census calendar time schedule;
- d) to prepare the census budget;
- e) to supervise the census cartographic work;
- f) to direct the census publicity campaign;
- g) to provide an effective cost control and administrative system for census funds materials;
- h) to recruit and train the required personnel for the census operations;
- i) to procure the necessary equipment, supplies and materials for census work;
- j) to develop the manual and mechanical data processing plans;
- k) to evaluate and analyse the census results;
- l) to tabulate and publish census data;
- m) to prepare a methodological report of the census operations;
- n) to provide the central government with periodic progress reports;

International Organization of the Census Head Office

A. The Director

13. The head (or the director) of the census office is responsible to central government for the execution of the census plan and conduct of the census operations.
14. Immediately after the authorization of the creation of the census head office is secured, the Director's first task is to procure suitable office space for the census staff including the administrative and cartographic staff.
15. The office building should provide space for the director, administrative services, cartographic unit, if not to be housed in the national geographic institute, storage space for office supplies and equipment. Also, the office grounds or compound should provide parking space for census vehicles.
16. The next task for the director is to set up the administrative unit and install the census cost control, accounting, personnel and administrative system. Possible sources for the personnel for the administrative unit are the Accountant General's Office and the Departments of Interior, Transport and Communications, Finance and other government departments.
17. An effective and efficient administrative unit is essential to success of the census operations.
18. In accordance with the census plan and calendar, the director will create and staff the following units of the head office:
 - a) Administrative unit
 - b) Cartographic unit
 - c) Census methodology unit
 - d) Field organization
 - e) Central control unit
 - f) Data processing unit
 - g) Data evaluation and analysis unit.

B. The Administrative Unit

19. The Administrative Unit will have responsibility for the following tasks:
 - a) Assist in the recruitment of technical and non-technical personnel;
 - b) Administer selection tests for temporary personnel;
 - c) Maintain personnel records and files;
 - d) Maintain time and attendance records for payroll purposes;
 - e) Assign employee numbers and identification cards;
 - f) Set-up an accounting systems to control the disbursement of census funds;
 - g) Maintain logs and issue motor fuel vouchers for all census vehicles;
 - h) Control the storage and distribution of all census supplies and equipment;
 - i) Supervise the maintenance of the census office building(s);
 - j) Have responsibility for the printing and reproduction of census manuals, forms etc.

C. Census Cartographic Unit

20. The census cartographic unit is the most important unit of the head office. Complete coverage of the country for census purposes depend on quality of the maps, listings and the master geographic code file produced by this unit.

21. The cartographic unit can be an integral part of the head office, national geographic institute or land surveys department (or ministry), depending upon whether the latter two are in the country's governmental structure and they have space for census cartographic operations. If the cartographic unit is to be located in the head office building, the geographic institute and/or land surveys department are potential sources for key personnel and surplus cartographic equipment for use in the census cartographic operations.

22. The cartographic unit will have responsibility for the following tasks:

- a) Map procurement;
- b) Preparation of locality lists and place-naming;
- c) Map preparation;
- d) Delimitation of enumeration areas (E.A.'s.);
- e) Development of the geographic identification code scheme;
- f) Preparation of the source document for the geographic identification code list for data input preparation section for the computerization of the master list.

23. The head office director or cartographic unit supervisor should determine the existence of recent base maps or satellite imagery of the country. If they are available, the required number of copies should be procured.

24. In the preparation of locality lists, measures should be taken to involve the field staff, supervisors and enumerators in the listing operation. Also, dwelling unit counts and population estimates should be obtained for each locality as a part of the listing operation.

25. Census map preparation can be done by the use photographic reduction, by draughtsmen or field sketching. Whatever the medium used, the complete coverage of all localities in the country will depend on the quality of the map preparation.

26. The lowest geographic publication level and the requirements for small area data, below the lowest geographic publication level, for planning purposes, etc. will determine the design of the geographic identification code scheme. Once the code scheme design is completed, preparation of source documents (transcription sheets) can commence.

27. The master code list should be computerized for control purposes during the computer validation and correction processing, at which time a check for duplicate and missing E.A. records will be made. If the master list is not computerized this check would have to be manual operation.

29. All maps will be indexed and filed in the Cartographic Unit until distributed to the field offices just before census enumeration begins.

D. Census Methodology Unit

30. The Census Methodology Unit's membership should include the heads or chiefs of each of the units in the Head Office, subject-matter specialists as well as the director. This unit need not be organized on a permanent basis. Once the census programme, plan and calendar have been approved. The Unit's main function will be to co-ordinate the census programme and develop the detailed methodology for enumeration, data processing and the tabulation and publication programme.

31. This Unit will take the appropriate measures to ensure that the census plan is executed in the proper manner.

E. Field Organization

32. The census field organisation is responsible for the collection of raw census data in the field. If regional statistical offices exist as part of the country's permanent statistical organization, key census staff members can be seconded from the regional statistical offices to the regional census offices. If no permanent regional statistical organization exist, regional census office must be created, utilizing personnel having previous general statistical and administrative experience from other government departments.

33. The heads of Regional Census Offices should be recruited in the early stages of the census preparatory work. Their first order of business, after the organization of their immediate offices, will be recruit personnel for and organize the district and local field offices in their regions. The district and local offices should be partially staffed with people in time to assist with the cartographic work, including the preparation of locality lists. Their participation in the cartographic field work will afford them the opportunity to familiarize themselves with their local areas prior to enumeration.

34. The primary source for the recruitment of field supervisors and enumerators in many African countries has been school teachers, and senior school students, in addition to the use of other government officials on secondment from other government departments. The National Census Commission can be of great assistance in influencing the government departments to release the required staff on a part-time or temporary basis.

35. Particular attention must be given to the choice of the system of payment for the field staff. The Report of the Seminar on the Organization and Conduct of Censuses of Population and Housing (Vol. I, para. 74) states, "The participants were unanimous in their support of the principle of the lump sum payment, but several favoured the view that it should be supplemented by a bonus payment, the amount of the bonus being determined by various criteria which reflect the efficiency of the enumerators work." This system of payment was supported over (i) a lump sum for the training period plus daily or hourly rates for enumeration; payment for each person enumerated and no payment at all. The size of the lump sum payment should be governed by whether the enumerators were previously unemployed or are seconded from other jobs and still receiving their regular salaries during the period of secondment to the census operation. Varying payments are also suggested for the temporary field staff that is held in reserve and are not used in the census enumeration.

36. The temporary field staff is a good source for recruitment of editors, coders and punch operators on the Data Processing Unit of the Census Head Office.

F. Central Control Unit

37. The Central Control Unit will have the following responsibilities:

- a) Control of the enumeration materials, i.e., maps, enumeration books, visitation records, etc., sent to the field offices;
- b) Check-in of the enumeration materials returned from the field offices to the Census Head Office;
- c) Compilation of provisional results by district, province (or governorate) and the national total;
- d) Control of the distribution of enumeration materials and the maintenance of the central files.

38. The master geographic identification code list should be used as the basis of the central control system. This unit should be able to follow the movement of enumeration booklets through the central office processing operations.

G. Data Processing Unit

39. The last expansion of the Head Office staff will occur for the census data processing operations. Relatively large numbers of temporary personnel must be recruited and trained as editors, coders, verifiers and data input machine operators. As mentioned in paragraph 36 above, a good source of personnel for the Data Processing Unit will be the persons released from enumeration staff, except for teachers and students whose school holiday ends before the data processing operations are completed. It may be possible to use those teachers and students located in the same place as the Head Office in the evening and night shifts.

40. The data processing operations should begin as soon as the first questionnaires for a given locality are received in the Head Office, with a preliminary check to determine if certain key questions have been answered satisfactorily. Unacceptable questionnaires will be returned to the field for re-enumeration. This procedure will prevent unacceptable questionnaires from being further processed and at the same time reduces the time between the initial interview and the subsequent re-interview.

41. The next step in the data processing operation is the manual operation. This operation should be performed under stringent conditions with precise and detailed instructions. In the field edit corrections are made while the enumerator is in contact with the respondent, whereas in the office edit, decisions are based on what is assumed to be the most probable entry from other information on the census questionnaire. Editors must be thoroughly familiar with not only the edit instructions, but also with the questionnaire(s) concepts and enumerator's instructions.

42. The office edit can sometimes be reduced, depending upon the nature of the mechanical or computer edit.
43. It may be desirable to combine the editing and coding operations, if the questionnaire is relatively short and simple. However, if the questionnaire is long and/or includes questions on the economic characteristics of the population, the editing and coding operations should be separate.
44. As far as the coding methodology is concerned, it will be determined by whether there are precoded check boxes included on the questionnaire and the complexity of the items to be coded. The structure of the data coding scheme must be determined by the data processing unit in collaboration with subject-matter specialist.
45. In order to reduce the time lag between the collection of census data and its tabulation, the question of the verification system to be used in editing, coding and data input preparation demands thoughtful consideration. In the African situation the predominant verification system has been 100% verification. The use of this system doubles the cost and time factors for these operations. Considerations should be given to using a combination of 100% and sample verification. Each operator would begin on 100% verification. The supervisor would review all errors with each operator and retrain those operators whose performance is unsatisfactory. Each operator whose work is of acceptable quality, is then placed on sample verification. Whenever a work batch fails tolerance, the entire batch and all subsequent batches are 100% verified until the quality level of work becomes acceptable. When this occurs the operator reverts to sample verification. Those persons with poor performance are re-trained, encouraged to improve or if warranted, removed from the operation.
46. The prime objective of quality control is to obtain the best possible results from each employee without expending excessive amounts of time and money. Directors of census head offices should not let their/inexperience with this type of quality control plan deter them from giving it a fair trial.
47. The next step in the data processing operation is data capture or data input preparation. There are four main data input media. They are (i) punch cards, (ii) paper tape, (iii) key to magnetic tape/disc/cassette and (iv) optical mark/character recognition devices. The medium selected for use in the census operation will depend on cost, time and availability of staff.
48. The world paper shortage has caused the cost of punch cards to "sky rocket" in relation to the prices of the other data input media. In addition, punch card! production rates in Africa are significantly lower than in other areas. However, the cost of optical mark/character recognition documents have remained relatively stable, aside for normal inflationary influences. This situation may change after current inventories have been depleted.
49. The location of the Data Input Preparation Unit is another problem area. In most African countries the data processing equipment and staff are part of the national statistical agency or located in the central data processing agency. It is preferable to have the census data input preparation unit located in the Census Head Office in order to maintain effective control of the operation and to avoid the administrative and logistical problems associated with moving census source documents from one building to another.

50. As far as verification of the data input preparation is concerned, the 100% sample verification plan described in para. 45 above should be applied.
51. After the data have been converted in to machine readable form, the next step to check it for completeness and consistency. This phase is usually performed in two stages. In the first stage the completeness, validity and consistency checks are performed on single records only. Whereas, in the second step the checks are performed on groups of records, i.e. family groups, household groups, concessions, etc.
52. In the correction processing that is attendant to the data validation, again close collaboration between the data processing and subject-matter specialists needed. Tolerances for data acceptability and the data amendment procedures should not be left to the data processing specialists alone.
53. Another problem area in the data processing operation is to what degree manual intervention is to be utilized. A poorly organized system can play havoc with the processing timetable and possibly introduce more errors than those that were originally present.
54. The tabulation of census data is the last step in the data processing operation. The introduction of computer software packages like CIENTS and COCENTS in African countries have solved many of the problems of tabulating census data. It must be noted that these and other tabulation software packages only reduce the programming work load for tabulation only. Programmes have to be written to validate, correct and organize the census data files before CIENTS or COCENTS packages can be used.

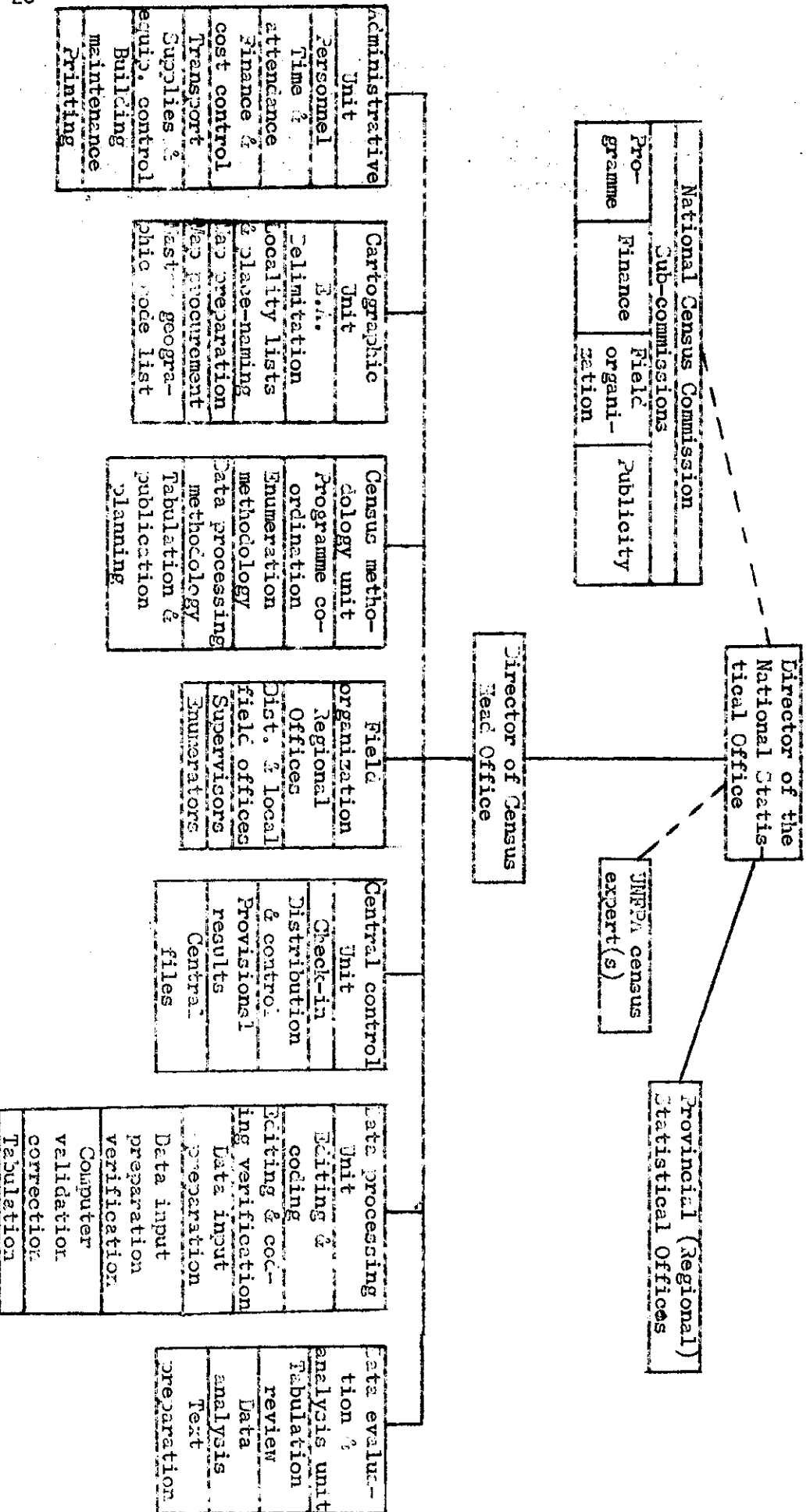
H. Data Evaluation and Analysis Unit

55. The Data Evaluation Unit will be responsible for the following tasks:
- a) Reviewing the census data tabulations before they are printed and published;
 - b) Analysis of the census final results;
 - c) Writing the analytical text for the census publications.
56. This unit consist of subject-matter specialists with specific tasks to perform in connexion with the census final results. They will be primarily concerned with detecting coverage errors and errors of content.
57. In the African situation, the census final results usually cannot be checked against records from other sources, such as population and birth registers. However, the data can be compared with school enrollments, and foreign resident registers.
58. The Report of the Seminar on the Organization and Conduct of Censuses of Population and Housing, (vol. I, para. 208) states, "Analytical checks of the reliability of the data obtained. These are indirect methods detecting errors in the enumeration consisting of the critical analysis of the internal consistency of census results and finding out how far the results conform to expected values obtained from other sources. These methods cannot, in themselves, produce an assessment of accuracy; all they can do is to produce a clue to possible errors which must be followed up by additional analysis designed to prove possibilities."

59. In conclusion, the suggested organization of the Census Head Office is not intended to be a blueprint to be used without modification in each African country. As mentioned earlier, local conditions, availability of staff, etc. can effect the shape and size of the Head Office in any given country. However, the Units discussed in this section are based on functions and tasks that have to be performed in the organization and conduct of a national census.

Annex

ORGANIZATIONAL CHART OF A CENTRAL CENSUS ORGANIZATION



IV. PREPARATION OF MAPS

A. Introduction

1. The first and principal goal of the cartographic operation is to provide, within the required period, maps of enumeration districts (E.D.) for the areas in which the census is to be taken.
 - (i) Each map must cover one area which is entirely located within a single administrative subdivision, can easily be identified on the ground and can be covered rapidly by an enumerator.
 - (ii) Each map must be prepared at such a scale that it is easy to use and to read, yet of a manageable size.
 - (iii) Lastly and most importantly, each map must make it possible to locate all populated places, with their exact place names and their administrative status clearly specified.
2. The greater part of tropical Africa is covered only by reconnaissance maps, which fall far short of meeting the requirements of maps for census purposes. Large areas which are inaccessible and lack any kind of infrastructure have so far been omitted from any genuine detailed cartographic coverage. On the other hand, other, more well developed areas are affected by substantial population movements related to the construction of new tracks and the establishment of new plantations; this process disrupts the appearance of the area within a few years and makes the already incomplete maps totally unusable.
3. Lists of localities, prepared in most cases for basically fiscal purposes, constitute the only source of demographic data. Such lists are compiled on the basis of information supplied by local authorities, which are rarely in a position to supply full information and sometimes have no reason to do so.
4. The fact that different lists compiled at various times contain similar data in no way guarantees that the information they contain is exhaustive or accurate. The earliest list was probably quite simply used as a basis for the subsequent lists, and the minor differences which may be observed between the various lists derive more often from errors in copying than from actual corrections made after on-the-spot observation.
5. The boundaries between administrative units, if any, have never been marked out on the ground, which is often impassable; such units have been identified merely on the basis of the traditional status of households under administrative or customary authorities. And the representation of such boundaries on maps is only very approximate.
6. The most developed countries possess basic map coverage at a small scale (1:150,000 or 1:200,000) prepared from aerial photographs at a medium scale (1:50,000 or 1:65,000). These maps, prepared rapidly during the period 1950-1960 using modern photogrammetric survey techniques (aerial triangulation) with a strict minimum of ground-based operations, contain serious gaps inevitable because of the scale used and because of the technique of photogrammetry itself.

7. It is evident that many cultural features which are essential for maps for census purposes (small localities, residences scattered along watercourses, etc.) and which may be identified or at least detected on 1:50,000 aerial photographs cannot appear on a map at 1:200,000 (1 millimetre = 200 metres), which is of necessity an abstraction. In addition, photogrammetric plotting is sometimes unsatisfactory in forested areas; and in no cases does it furnish place names. At the same time, the collection of such place names from information supplied during field operations produces lists that are very incomplete and sometimes in error (as a result of the noting of names by an outsider, or the confusion of names).

8. Accordingly, it is essential above all to update existing maps. This implies, principally, a need for ground operations, much more than survey, consolidation and compilation work. The cartographic technique to be applied is called field classification. This operation, completely freed from any concern for geometrical precision or for the general updating of planimetric data, must be strictly adapted to the requirements of the census alone. Nevertheless, it must not be limited to a check in the field that the lists of localities agree with the existing map, accompanied by a "free-hand sketch". What is needed is a genuine reconnaissance topographical survey, sweeping the whole country and accurately locating all populated places with their correct names, the number of places of residence, the practicability of access routes and a more accurate definition of their administrative boundaries. It is only after this fundamental work has been completed that a valid list of localities can finally be prepared.

9. The preparation of E.S. maps also requires basic drawing work: tracing for reproduction by photogravure. This operation may be simplified considerably if care is taken to standardize the format and scale of the documents used in the field and in the office, and to limit compilation work to a minimum.

10. The task of publishing the results of the census in the form of topical maps and diagrams assembled in an atlas calls for the use of pure cartography; but it should be noted that it is only at this final stage that the cartographic artist is needed. Furthermore, the countries concerned often possess bodies perfectly equipped and fully competent to deal with these specialized publications.

11. It is therefore essential that the map-making operation in the census-taking process should be regarded in its true light and its full extent, and that the necessary time, money and technical resources should be devoted to it. Failing that, the use of incorrect and incomplete E.S. maps will lead to the erroneous identification of populated places and, especially, to systematic under-enumeration, which is incompatible with the fundamental principles of the census.

B. Basic Documentation

12. The document which provided the maximum amount of data on the location, distribution and size of the population and on the physical environment and type of habitat is incontestably the aerial photograph. Even if it is at the same scale, a map cannot provide the same wealth of data as a photograph, for the simple reason that a map is always a conventional representation which necessarily implies a degree of abstraction, that is, the elimination of one feature to show a more important feature.

13. The aerial photograph has two uses in cartography for census purposes. Firstly, it enables populated places, however small they may be, to be located easily; secondly, it facilitates the task of determining boundaries between enumeration districts by highlighting all the natural features (confluence of two wadis, disposition of rocks or dunes, an isolated tree, etc.) which may constitute reference points for drawing E.D. boundaries. More specifically, in urban areas, and particularly in working-class districts where homes are arranged in haphazard fashion, the preparation of E.D. maps poses no problems if recent, large-scale aerial coverage is available.
14. Practically all African countries have received comprehensive photographic coverage at least once, at medium scale (1:50,000 or 1:65,000). These photographs, even if they are 10 or 15 years old, are unquestionably the best basic documents available. Acquiring such coverage, which is relatively cheap (2 cents per km²), should be included automatically in the budget plans for any census.
15. Financing of a new set of photographs is, of course, more expensive; however, it should not be forgotten that such an operation would be of general interest to a large number of governmental agencies, which might therefore share the costs. At all events, a new set of photographs at a large scale is essential for all large urban centres, and especially for the capital. The photography could be effected at 1:3,000, permitting enlargements to 1:2,000. The cost of such an operation is estimated at between US \$500 for a town of average size.
16. Equally, new photographic coverage at medium scale (1:50,000 to 1:70,000) is essential for rural areas which are densely populated and are affected by substantial population movements. Medium-scale photography costs an average of between US \$0.00 and US \$1 per square kilometre.
17. Independently of conventional aerial coverage, useful photographs can also be obtained with the use of amateur techniques (Cessna aircraft equipped with a Hasselblad cine-camera), or by requesting the assistance of the air force of the country concerned. Ivory Coast and Senegal, for example, have the potential to acquire reconnaissance aerial coverage of very high standard.
18. Notwithstanding the shortcomings already referred to, the existing base maps in a number of African countries are not without interest. Such maps are at a well defined scale, whereas aerial photographs are only at an approximate scale. Moreover, even if they are incomplete and sometimes incorrect, the maps supply information on place names and on the approximate line of administrative boundaries. The base map, in brief, represents a "rough draft" of the final document which will be prepared after a detailed updating operation in the field.
19. As a rule, the base maps for African countries were prepared at a small scale (1:200,000 or 1:500,000). In many cases, however, a new medium-scale map (1:50,000) is being prepared and already covers part of the country. Needless to say, when there is a choice, even on the local level, between the two maps, the medium-scale map should be used, since it will provide the maximum amount of information.
20. A new cartographic technique has been developed over the past few years to produce what are known as orthopictomaps. By using photogrammetric equipment coupled with orthoprojectors, it is possible to obtain a document which combines the fidelity of an aerial photograph with the accuracy of a conventional map.

These orthophotomaps will, in the near future, constitute the ideal basic document for census cartography. Unfortunately, very few areas of Africa have so far been covered by orthophotomaps.

21. On the other hand, the images transmitted by ERTS (Earth Resources Technology Satellites) and SKYLAB are for immediate purposes a happy compromise between the summary reconnaissance map and the conventional aerial photograph. Constantly updated, since the satellite sweeps the same area on the earth's surface every 10 days (every 10 days in the case of SKYLAB), and susceptible of being enlarged to 1:250,000 and even, more recently, to 1:100,000, these images are of great interest for the Sahelian and desert countries, which are mostly covered only by 1:200,000 or 1:500,000 maps.

22. In tropical Africa, cadastral maps generally cover urban areas, and are rarely kept up to date. In addition, they are issued in most cases in the form of general maps or property maps, i.e. they simply show the delimitation of units of property, but not the arrangement of buildings. Consequently, they are of limited usefulness (delimitation of urban boundaries, indication as to district and street names).

C. Methodology

23. Urban areas. Aerial photographs of very recent date should be used, preferably enlarged to 1:2,000. From these enlargements a reproducible film can be prepared which facilitates the printing of Ozalid copies. Taking the Ozalid copies, the topographers go into the field in order to mark the urban boundaries and those of the various smaller administrative subdivisions. They collect or verify district and street names, and fill gaps in the toponymy using a logical numbering system based on the centre of the area concerned. They distinguish between buildings used for administrative, commercial or residential purposes, and make an approximate estimate of the population by block. Finally, they number residences, both on the map and on the buildings themselves. The boundaries of E.C. are then established within the blocks whose limits have already been determined, on the basis of the pre-enumeration carried out on the ground.

24. Rural areas. The first task is the preparation of "planimetric sketches" on tracings or transparent material. These sketches may be prepared either by simple copying of the medium-scale map, where it exists, or by enlargement of the small-scale map. For countries where there is no existing base map at least at 1:200,000, it is preferable to use aerial photographs directly.

25. On to each planimetric sketch should be transferred lines of communication, administrative boundaries, hydrographic information and important relief lines, as well as localities whose position on the base map and whose name are not challenged.

26. The scale of these sketches is selected on the basis of the density and distribution of the population. The following average figures are valid:

For population density lower than 3 per square kilometre	: 1:200,000
For population density lower than 10 per square kilometre	: 1:100,000
For population density lower than 50 per square kilometre	: 1:50,000
For population density higher than 50 per square kilometre	: 1:20,000

27. The format of the sketches should be standardized so as to facilitate subsequent printing and assembly. The ideal format is one which substantially corresponds to the map of a control area, i.e. between 5 and 10 enumeration zones.
28. The preparation of a 50 x 50 centimetre 1:50,000 planimetric sketch requires about two days' work for a tracer. The work may be spread out over a fairly long period (6 to 8 months) and may thus be entrusted to a fairly small unit of draughtsmen.
29. At the same time a "survey record" of practical format (30 x 30 centimetres) must be prepared. Like the sketch, this record will be prepared either on the basis both of the medium-scale map and of aerial photographs, or on the basis of aerial photographs alone. The "survey record" should contain all the data which are transferred onto the sketch, plus all the information which can be discerned from the photograph and which must be checked on the ground. The preparation of a 30 x 30 centimetre survey record requires an average of three hours' work, and should be entrusted to the operator who will be responsible for the updating operation on the ground.
30. The updating on the ground in rural areas is by far the most difficult operation, and the most costly. However, it is on this basic operation that the accuracy of the enumeration and the quality of the census itself depend.
31. The operation involves sweeping the whole area and marking on the record all populated places. These populated places, most of which already appear on the photographic base, must be located as accurately as possible and represented schematically in relation to the communication route which is followed (road, track); the places of residence must be counted and the appropriate figure transferred onto the survey record. The place names which already appear on the record must be checked, and must be added to where necessary. Through the use of a set of conventional signs, the practicability of the routes of communication must be distinguished; this will provide valuable data when the E.D. are divided up.
32. During the completion topographic survey, the operators must determine the ratio of number of residents to number of places of residence, at least once for each 30 x 30 centimetre record. These data will be used in the dividing up of the E.D. Administrative boundaries, especially those which are not defined in detailed texts and which are represented only approximately on existing maps, must be located with greater accuracy with the use of information gathered on the spot in localities near the anticipated line of the boundaries.
33. As the survey records are completed in the field, they must be checked against aerial photographs, lists of villages and administrative census data. They will subsequently be reproduced on the appropriate planimetric sketch, which will already contain the principal planimetric features and a proportion of the place names.
34. Once a series of sketches has been completed, the E.D. are divided up. In this operation, while natural boundaries should be followed as much as possible, an effort should be made to delimit homogeneous units of population and to ensure that each district can be covered by a single enumerator. This dividing-up operation should be supervised by those in charge of the census, with the help of a geographer.

35. When the division into E.C. and control zones has been completed, work can be begun on the preparation of an exhaustive list of the localities covered, not by compilation and control which is more or less effective, but using systematic sweeps of the entire area.

D. Personnel

36. The preparation of E.C. maps is a task for specialists, on the same basis as the other disciplines required in the comprehensive census operation. Accordingly, it is desirable to avoid interference by academics or statisticians in this work, which has nothing to do either with research or with the survey. Proper census maps should present directly in visual form all the elements necessary for the dividing up of E.C., without any formulae or explanatory notes. If well made maps are required, there's nothing more logical than to entrust the work to topographers or cartographers; the Census Office will be involved only as the requesting body, in order to specify its needs.

37. The number of persons required for map preparation obviously depends on the area of the country and the size of the population, as well as on the time available. It may be estimated that, on average, a topographic operator can prepare the equivalent of 8 to 10 E.C. maps per month.

38. When the country concerned possesses a Geographical or Topographical Service, it is absolutely essential that the Service should play an active part in the preparation of census maps, either directly, by assuming full responsibility for the operation, or indirectly, by providing basic documents (maps and photographs) and by seconding qualified staff to direct and supervise the work. Such co-operation is all the more justified in that it is embarked on in a context of reciprocity. The preparation of E.C. maps for the entire country, with stress laid on locating and determining the names of populated places, is an important contribution to the updating of the country's base map.

E. Expert

39. In the case of countries with an area of at least 150,000 square kilometres and a population of over 2 million, which also lack a Geographical Service sufficiently well staffed to undertake cartographic operations, it is desirable for a cartography expert to be assigned. This expert must not be solely an adviser in the field of cartographic compilation and composition; he must also possess topographic knowledge which will enable him to make a sound choice of the appropriate method so as to make the best possible use of all existing documents. First and foremost, he must be a man who can work in the field, who is familiar with photo-identification and photo-interpretation techniques, and who can train topographers to carry out completion reconnaissance mapping.

40. In order to limit the numbers of such cartography experts while increasing their efficiency, it is not inconceivable to envisage assigning them on a sub-regional basis for the preparation and supervision of work in two or more neighbouring countries.

F. Duration and Cost

41. The time required for the preparation of maps for census purposes depends on fixed parameters such as area and population, but also on unforeseeable factors (weather, health of the staff, mechanical failure, etc.) which are inevitable in any large-scale operation in the field. Moreover, it would be unreasonable to seek to reduce the time required to an excessive extent through an ill-considered increase in staff. As a result, between 8 and 15 months on average should be anticipated for the completion of a cartographic operation for census purposes.

42. Hypothetical estimates of the cost of preparation for census purposes have often been put forward, based on the conditions obtaining in Europe and the United States, where the preparation of base maps is practically up to date and, consequently, only office work is required. These estimates, which amount to about 10 per cent of the total cost of the census, are manifestly inadequate to cover substantial updating operations in the field, as are required in Africa. An estimate of the order of 20 per cent would certainly be more realistic.

V. SAMPLING

A. INTRODUCTION

1. The advantages of using sampling in place of exhaustive enumeration for the collection of data during a census are well-known. It saves cost, saves time, gives sometimes more accurate results, and sometimes perhaps the only method feasible. Also known are its disadvantages; for example, theoretically at least, a complete census gives the exact answer, but the sample gives only an estimate. Moreover, since the accuracy of the sample estimate depends on the absolute size of the sample and not on the sampling fraction, it is difficult to produce acceptable estimates for very small areas through the use of sampling unless sample enumeration becomes almost equivalent to complete enumeration so far as coverage is concerned.
2. "The rapidly growing needs in a number of countries for extensive and reliable demographic data have made sampling methods a very desirable adjunct of any complete census. Sampling is increasingly being used for broadening the scope of the census by asking a number of questions of only a sample of the population. Modern experience in the use of sampling techniques has confirmed that it is necessary to gather all demographic information on a complete basis." ^{1/}

B. SHORT AND LONG QUESTIONNAIRES

3. Joseph Waksberg^{2/} has emphasized on the use of sampling as a means of improving the timeliness of the data as well as for achieving greater accuracy. He has recommended that only a bare minimum of information be collected on a 100 per cent basis. Some items of data are definitely to be collected on a 100% basis, because legal requirements demand this. Other items of information may safely be collected through a sample. The African experts have recommended that the total population by sex should be the minimum information to be collected on a 100% basis during the 1970 round of population censuses in Africa.^{3/} All the countries also want the information on age, and thus the basic minimum stands to be the age-sex distribution of the total population to be obtained through the exhaustive count. In practice, however, the basic minimum differs from country to country according to the individual requirement of each country. Moreover, it becomes sometimes beyond the control of the census office to restrict the questionnaire for the 100% count to a bare minimum.
4. It is understandable that since a national population census is a multi-purpose statistical project, a fairly large number of different topics must be investigated. This often makes the questionnaire so heavy that it becomes practically impossible to collect the information from all units of the population. In some countries with small population such as Gambia (0.5 m.) ^{4/}, Libya (2.5 m.) ^{4/}, and Congo (1.03 m.) ^{5/}, sampling has not been used at all for data collection. While the advantages of using sampling for data collection may look very tempting, one must remember that it involves not only a lot of technical complications, but also a lot more of stricter administrative control as well as operational checks. Lack of needed supervision in the enumeration of the sampled units may result in very bad returns of the data, and the resulting estimates may be seriously biased if we want to calculate them at all. These are the reasons

^{1/} Principles and Recommendations for the 1970 Population Censuses, UN publication.

^{2/} Demography (1965)

^{3/} The African Recommendations for the 1970 Population Census. ECA publication.

^{4/} Official 1973 population census figure.

^{5/} ECA estimate for 1973.

which led Senegal (4.2 m.)^{5/}; Sierra Leone (2.6 m.)^{5/} and Ivory Coast (5.6 m.)^{5/} to decide not to use sampling for data collection during the census. Lack of enough technical personnel has forced some other countries like Gambia and Niger, to plan a demographic survey to follow the census after a certain period of time; the survey will be conducted to collect the supplementary information.

5. A typical procedure to use a built-in sample at the time of the census is, however, to make an exhaustive enumeration in the urban areas using what is called a 'long' questionnaire containing all the topics to be investigated during the census, to make an exhaustive enumeration in the rural areas using what is called a 'short' questionnaire containing the basic minimum of the topics on which information is needed for the whole population, and finally to use the long questionnaire in a sample of the rural population, the sample size being determined primarily by the accuracy desired of the sample estimates. As an example one may refer to Sudan (14.1 m.)^{6/} which used sampling for data collection during its 1973 population census following the method outlined above. The short questionnaire contained information on Name, Sex, Age and Relationship of the respondent with the Head of the Household. It was used exhaustively for the whole population except where the long questionnaire was used. The long questionnaire contained those four items together with questions on marital status, literacy and education, economic activity, fertility, mortality and survival of parents. This was used in the urban areas and in a sample of rural areas. A similar plan has been adopted by the Central African Republic for its census to be conducted in December 1974.

C. SAMPLING AND PILOT CENSUS

6. It is well-known that in order to take suitable measures sufficiently in advance against all possible pitfalls during the census operation and also to design every phase of the census operation with optimum efficiency, it is necessary to conduct pilot censuses before launching the actual census operation. The results of these pilot censuses determine the guidelines for the census as a whole as well as, if possible, for each of its phases separately. They are always carried out on a sample basis. Except in such cases where, for example, it is needed to test "the effectiveness of a projected course of action"^{7/}, it is not necessary to use random sampling for these pre-tests. One may conveniently use non-random or purposive sampling which has been the case with the pilot censuses organized in the countries taking census under the African Census Programme. In this connection one must mention the wise decision of the census in Ethiopia to use random sampling to judge the efficacy of the group enumeration method proposed to be followed during the population census in Ethiopia. The conclusion drawn on the basis of the results of the pilot censuses using random sampling was that the group enumeration method gave 10 per cent less coverage (under-enumeration) than the house to house canvassing method.^{8/}

7. In Congo pilot censuses were conducted covering the population of one entire province, Lekoumou. The data collected during the pilot census were utilized to make a sampling frame for the pilot surveys for establishing a system of continuous demographic observation in the country after the census work will be over.

^{5/} May be revised.

^{7/} Principles and Recommendations for the 1970 Population Censuses.

^{8/} Personal communication from UN Sampling Adviser in Ethiopia.

C. In Somalia a number of pilot censuses have been conducted to test the feasibility and efficiency of a new sampling design proposed to be used during the census to collect information among the nomads. In order to reach unbiased conclusions the pilot tests should have been conducted using random sampling for the selection of sample units where the tests would be conducted. As a valid sampling frame was not available, tests were conducted using non-random selection, but conducting the tests under as varied conditions as possible. The results of the pilot censuses have helped the census office to modify the questionnaire as well as several basic concepts with reference to the enumeration of the nomads.

9. Pilot censuses will be conducted in Mauritania exactly one year before the census enumeration period in order to assess the results under identical conditions as far as practicable. Among other inquiries, the results of these pilot censuses will help to determine among several alternative procedures that have been proposed the optimum sampling design to be used during the census for data collection.

D. SAMPLE DESIGN

10. Regarding the choice of the sampling unit and the sampling design to be used for data collection during a population census, the following recommendations of the United Nations Statistical Office are useful. "Because basic conditions differ in different countries, it is difficult to lay down any general rules concerning the choice of sampling units employed at various stages of a multistage sample design. In most African countries it may be assumed that any sample field operation in relation to a census is likely to be based on a single-stage sample of areas; such area units should preferably be approximately equal in population and an estimate of population of each unit should preferably be available. Census enumeration areas are often convenient units for this purpose." 2/

11. In the light of these recommendations, one may consider the practical advantages of the single-stage cluster sampling with census enumeration areas as sampling units, although it may very well be that a more efficient sample design would be to sub-sample households, the second-stage sampling units, within the sampled enumeration areas, the first-stage sampling units. In general, a single-stage approach will have the following advantages:

- a) A two-stage design with households as second-stage units requires necessarily two visits to be made to the selected households—one for the listing operation and the other for the enumeration. Although this may be desirable in order to avoid omission or duplication of any household during the census, this may not often be feasible costwise as well as operationally in difficult terrain. Moreover it may always be extremely time-consuming to send back the household lists to the central census office or even to the regional census office for the second-stage samples to be drawn. On the other hand, the results may be very much biased if the task of drawing samples is entrusted to the enumerators.

2/ Use of Sampling in Population and Housing Censuses. Doc. No. ST/STAT/23 and E/CN.14/CPH/8.

- b) If the enumerator obtains sample information from everyone in a sample enumeration area it is easier to crosscheck the information from the adjoining neighbours who are also in the sample. There is more opportunity to get some information about the households that are temporarily absent. It is also easier to avoid double-counting of some events.
- c) When the enumerators are of questionable quality, sub-sampling requires a very strict supervisory control which may not always be guaranteed.
- d) It will not be necessary to train all the enumerators on all items of the long questionnaire. The better enumerators may profitably be used for the sample enumeration areas. Control of enumeration work is easier.
- e) Work and control of work at the processing stage will also be easier.

12. Single-stage cluster sampling design was used during the Sudan population census in 1973. In Liberia housing questions were investigated on a sample basis. But instead of using area sampling a different design was used. The questionnaire books were prepared in such a way that every 5th household supplied the answers to the housing questions. Care was taken to avoid the enumerator bias in the selection of the sample households.

13. It is necessary at this point to elaborate on the necessity of creating enumeration areas, suitable for building up a sampling frame. For discussing the suitability of the enumeration areas in order to achieve the best results one may recall the following suggestions from the UN Statistical Office: 10/

- a) It is desirable that each EA should if possible be entirely urban or entirely rural.
- b) The average size of the EA should approach as closely as possible the optimum for efficient sample inquiries based on the EA as sample unit. This optimum depends on the variate with which the survey is concerned. Studies in Africa and other developing countries suggest that for many variates the optimum would be around a few hundred population.
- c) It is desirable that the variance in the size of the EAs should be as small as possible.
- d) It is desirable to number the EAs approximately within each district, and the districts within each region, etc., so as to ensure on the one hand that contiguous geographic EAs are given consecutive numbers and on the other that the numbering provides a code indicating a certain characteristic of the EA (e.g. urban or rural character).

10/ Use of Sampling in Population and Housing Census. Doc. No. ST/STAT/23 and E/CN.14/CPH/8.

14. It may be noted here that although the recommendation has been made for the optimum EA size as two to four hundred persons, practical considerations on many aspects have forced many African countries to create EAs of larger sizes. In the 1973 census of Sudan, EAs, which were called Enumeration Zones there, were created with average size of around 600 persons, the size varying from 500 to 700 according to the concentration of habitation. But because it was found that it would be impossible to impose the necessary technical control the enumeration zones were chosen as sampling units, it was decided by the census office to take the enumeration sector as the sampling unit instead, an enumeration sector having been composed of five or six enumeration zones. Thus the areal sampling unit was of the size of 3,000 to 4,000 persons.

15. The average size of the enumeration area in Central African Republic is 800, in Chad 1,000, in Cameroon 1,000 and in Dahomey about 2,000. In all these countries recommendations have been made to take the EA as the sampling unit, discouraging its further subdivision simply for sampling purposes. The reason behind this was the fear that if proper cartographic supervision could not be made and if the EAs were subdivided by the enumerator himself in the field in order to draw one of the subdivisions in the sample, large subjective elements might bring heavy bias in the results. Of course some restrictions are automatically imposed because of the large size of the EAs. For example, tabulations should not be made for very small geographical areas for the characteristics under study through the use of sampling. But feasibility is the most important factor which may lead to the acceptance of a theoretically less efficient plan. One should note here that a study of the sampling variances and of intracluster correlation for the characteristics under study and of the influence of the size of the EAs on them will be very helpful in planning future surveys, and these should definitely be made.

16. When the sample size is even moderately large, it is much easier to draw a systematic sample from a list of sampling units than to select separately each unit to be drawn in the sample. Thus the recommended procedure is to adopt a systematic, or more precisely, a circular systematic sampling, since in a circular systematic sampling every unit in the list is given some chance to be selected at the first draw which is not the same case with linear systematic sampling if the number of sampling units in the list is not an exact multiple of the sample size. Therefore when the numbering of the EAs will be made it should be done each district following a spiralling movement from the outer perimeter gradually towards the centre. For the districts inside a province also the same method should be followed. The procedure can be easily adhered to if the numbering is done on a map containing the boundaries of the districts in a province as well as those of the EAs within each district. If the list of the EAs is then prepared following the given ordering of the serial numbers on the map, a circular systematic selection will ensure that the selected units will come from all over the region and thus the expectation will be there that they will form a representative group. The procedure outlined above has been followed in the Sudan census in 1973, and has been recommended to the African countries which have planned to use sampling for data collection using EAs as sampling units.

17. Often sample estimates are published at the province and the national levels separately for the urban and the rural areas. This suffices for the national and the regional planning purposes, and the estimates at lower levels of geographic or administrative sub-divisions are not required. There may of course be exceptions. For example, in Mali the sample estimates are needed at the administrative level of the circle which is at one step lower than the province.

In any case a geographical stratification provincewise or in such cases as in Mali, a stratification at a lower administrative level will have to be made. In some rare cases such as in Congo, this geographical stratification automatically coincides with a stratification according to the principal ethnic groups in the country. But if it does not, it is desirable that any further stratification should not be made within the geographical (administrative) strata, because this will give rise to technical complications. If it seems that the use of an available information for further stratification may result in a gain in efficiency in the sample design, it may be used for a post-enumeration stratification. This will be almost as efficient as that by proportional allocation in pre-enumeration stratification. Among the countries taking census under the African Census Programme, most probably only in Upper Volta in the post-enumeration survey for supplemental data collection following the population census, stratification will be made according to several criteria such as geo-ethnic composition, size of the village etc.

18. Nothing has yet been said on the size of the sample to be selected. Although the administrative and budgetary feasibilities are very important factors, one cannot underestimate the role of sampling errors in determining the sample size. A generally accepted principle, to start with, may be that the sample size should be such that if 10% of the population in a geographical area for which the estimates will be published, possess a certain characteristic, their number will be estimated with a maximum relative error of 10% at the 95% level of confidence. This level of error may not of course be accepted in one country whereas in another a higher level may not matter much. But if an acceptable level of error is decided upon, then on the basis of the sampling error of different estimated numbers of persons and for several values of the sampling fraction and of the intracluster correlation, this accepted principle may guide to the desirable sampling fraction that should be used. This may only be a very rough guide, but very often helpful in taking a definite decision about the sample size that should be realistic as well as sufficient to produce acceptable estimates. In general a sampling fraction between 5% and 10% is sufficient, but sometimes a sampling fraction of 2.5% may also be used, noting here that the sampling error depends on the absolute size of the sample and not on the sampling fraction. For example, Sudan used a sampling fraction of 10%, and it has been suggested that Cameroon should take 2.5%, Mali 5%, and Central African Republic 10%. One final note concerning the sample size is that it is much better to have a small sample with sampling error relatively high but nonsampling errors reduced to a minimum, than to have a very large sample which, due to lack of sufficient technical resources of the countries taking the census for the first time, may lead to results with large amount of nonsampling errors hidden in them.

E. SAMPLING AND QUALITY CONTROL

19. A population census or any census whatsoever at the national level needs a large number of operations to be performed. To ensure the success of the whole exercise, it is necessary to check at every stage that the operations are actually being carried out according to the directives issued from the central census office. These controls are to be imposed simultaneously with the different stages of the whole work so that corrective measures, if necessary, may be taken before it is too late.

20. It has been suggested that some of these operations are so important that 100% verification must be made to find out if there is any error anywhere. Some of these are as follows:

- a) Designation and mapping of the enumeration areas
- b) Preparation and printing of questionnaires
- c) Review of training materials and manuals
- d) Distribution of materials
- e) Preparation of sampling frame if sampling is used, and !
selection of the sample with proper identification of
each sample unit selected
- f) Scrutiny of the questionnaire books by the supervisors
for blank reporting, inconsistencies, etc.

The list may be continued. One will not normally think of checking less than 100% in those cases.

21. There are some other operations where a 100% checking is either not feasible or unnecessary. For example, the following three instructions are usually given to the supervisor before the census enumeration takes place:

- a) Check the enumerator's method of approaching the respondent
and his technique of interviewing.
- b) Check that interviews were really made when the completed
questionnaire is submitted and check also that no person
has been omitted.
- c) Check that the recorded responses are correct.

Regarding the first instruction, it is understood that the supervisor cannot make a 100% check, as in that case he will have to stay with one enumerator during the total period of his work. Also it is clear that the purpose of making this check is to instruct the enumerator at the early stage of his work if his method of working is not correct. If the supervisor feels that it may be necessary to continue the checking for one particular enumerator, it is desirable that the enumerator is replaced at an early stage by a more efficient one. Thus it is not necessary to use the methods of random sampling to make this check effective.

22. For the second and the third instructions, however, the random sampling methods should be used in order to produce unbiased results through checking. A sample of completed questionnaires will have to be selected at random. A systematic selection with a random start for each enumerator will eliminate the need to wait till all the questionnaires have been filled in, and the checking work may run almost simultaneously with the enumeration work. In order to avoid the dependency on the supervisor for the randomness of the selection, he may be instructed to check with a random start every 20th or 25th household questionnaire to find out if the interviews were really made, and every 50th or 100th household questionnaire for content checking. All records of the checks made should be correctly kept for every enumerator's work and for every enumeration area. Assuming that the supervisor will follow carefully the selection of the sample households, these records may help the central census office to form an overall idea of the quality of the work done during the census enumeration. It should be kept in mind, however, that in most of the countries the work of recruiting the enumerators is left to the supervisor, and therefore, it may very well happen that the supervisor will be reluctant to keep a record of all the defects. This reluctance will bring in a large amount of bias and therefore will make the results unusable.

23. It is recommended that for coverage checking against omission of an entire house or household, the supervisor should cover the whole of an enumeration area. It is well known that the quality of the census coverage of houses and households depends to a large extent on the quality of the enumeration maps as well as on the pre-enumeration listing of houses and households. In any case selection of only a part of the enumeration area instead of the whole to be checked for census coverage of all houses and households is usually discouraged.

24. It is only in Liberia that the random sampling methods have been used to control the quality of the enumerators' work. In all countries arrangements have of course been made for this checking, though the procedure of selection of units to be checked are not random and have been left largely to the discretion of the supervisors.

25. Sampling may be used in quality control of the office operations especially in pre-computer processing stages. In coding operation, for example, the supervisor of a group of coders may not make a 100% check of all the coded questionnaires. In that case a random check of a certain percentage of the questionnaires is desirable. A control chart should be made on the basis of the proportion of the mistakes made. This should be done for each coder separately. For the first two or three days of course a careful scrutiny of almost all the coded questionnaires will definitely show which immediate steps should be taken to improve the quality. The random checking and the preparation of control charts come after that step. It should be mentioned that if it is operationally feasible, then instead of selecting, say, 10% of the coded questionnaire books for checking, it is preferable to check 10% of the coded questionnaires in each book, since in that case the resulting control charts will lead to more precise conclusions. It is not known at this stage if any African country has decided to use random sampling for quality control and to prepare control charts in order to check and improve the quality of the coders. Similar procedure may be followed for the process of punching the cards containing individual or household information.

26. "The experience of various countries in the field of application of sampling to data processing has pointed to further opportunities for improvement of present plans and introduction of new sample controls. Moreover the effort to attain the better quality of census data in the phase of data processing has brought into focus the necessity of improving the quality of work done during the previous phases. In particular the need for an effective plan to control the quality of enumeration has been recognized. A considerable amount of progress has been achieved in measuring and controlling the quality of a census after it has taken place, but to date 11/ not enough is done about controlling quality at the time of the actual enumeration. Consideration of these problems would lead to the important question of integrating quality control of processing with the quality of work of the previous phases." 12/

11/ 1950

12/ Handbook of Population Census Methods, Vol. I. UN publication. 1950

F. SAMPLING AND ADVANCED TABULATION

27. The tabulation and analysis of all the information collected during the census operation normally take a long time to be completed. It has therefore been rightly recommended in the United Nations Handbook of Population Census Methods Vol. I that provisional tabulation should be made on the basis of a sample of the data collected. For this advanced tabulation a very simple procedure should be followed. The tabulations may be made only at the national level using urban-rural stratification.

28. If the census office in a country has not used sampling at all for data collection during the census enumeration, a simple procedure is to choose at random a sample of enumeration areas and then process in advance the information given in the questionnaires returned from these EAs. The EAs may be selected in the sample when the list of EAs has been prepared after the locality listing and the mapping work are completed. No special control should be placed on the enumeration or processing of the data in these areas, so that they may be taken as a representative group of the census enumeration areas. The only difference is that when the filled-in questionnaire books start coming in to the census office, the books from these enumeration areas should be taken up before others for coding and other processing work.

29. If a country decides to use a built-in sample for data collection, a sample of enumeration areas will have to be chosen where a long questionnaire will be used. For advanced tabulation it will be necessary to choose a subsample of the sample of EAs already selected. Work on the returns from the EAs in the subsample should start as soon as they come in.

30. It has been assumed above that a single-stage cluster sampling of EAs has been used for data collection. It may be decided instead to use a two-stage sample design with EAs in the first-stage and households at the second-stage as sampling units. Only the selected households are to be processed for advanced tabulation. But if the sample design may bring complications in the organization of the processing work, the plan should be avoided.

31. The process of advanced tabulation also incidentally provides a test of the census processing programme for all data. There is no doubt that the advanced tabulations provide useful information at an early date. However it may be argued that processing an advanced sample interferes with the processing of the regular census tabulations in the census office of a country with limited technical resources and delays the final publication. This is the principal reason given against advanced tabulation by the countries like Central African Republic, Cameroon, Dahomey and Senegal.

32. "In determining the size of a sample required for preliminary results, it has to be borne in mind that each increase in the size of the sample gives greater detail and more accurate results at the expense of speed in the analysis, for the latter decreases as the sample increases. In the interest of obtaining quick results, it is necessary that the sample be no larger than that required to give only the main characteristics of the population with no more than reasonable accuracy, say a coefficient of variation up to 5%. When punched cards are used to analyse a census, the only additional work involved in obtaining preliminary results from a sample is that concerned with the selection and the machine analysis of the sample. The coding of the sample forms and the punching

of the sample cards are a part of the work required for the complete analysis and need not be repeated for the latter." 13/

33. Except Liberia, no other country has a plan for advanced tabulation, although suggestions were given to several countries.

G. SAMPLING AND EVALUATION RESULTS

34. It is generally accepted that in the field of demographic, social and economic statistics, the attainment of exact values by means of a national census of population is unrealizable because of various factors beyond the control of the census office operations. The data can be collected only with different degrees of approximation. However, in order that the census data can be put to practical use, one should attempt to ensure that departure from accuracy does not exceed reasonable limits. 14/

35. Various methods have been suggested for finding out the types and magnitudes of errors in the census enumeration. One way is to reenumerate a sample of the total population and compare with the census results. One other way is to match a sample of census returns with the results obtained from other sources, for example, vital registration documents.

36. If a post-enumeration survey (PES) is conducted to check the accuracy of the census, it must fulfill certain conditions, namely, (i) the PES must be independent of the census, (ii) it should cover a representative part of the country's population, and (iii) a one-to-one matching of its results with the census returns should be possible. The whole basis of the PES to be used for evaluating the census is that its organizers must be confident from the very start of its planning up to the completion of its analysis that the PES results are being obtained with maximum possible accuracy and that the census results can be verified against them. It must be very clear to the organizers of the census and the PES that there is no point in reaching a stage where the need will be felt to organize a second PES in order to be sure about the accuracy of the first PES.

37. Sometimes PES is conducted to serve two purposes, (i) to check the quality of the census and (ii) to collect at the same time supplemental data that could not be collected during the census. But if it is considered that the PES should serve as a census evaluation survey, then in countries with limited technical resources it is advisable that the evaluation survey be kept separate from the PES for supplemental data collection.

38. For the census evaluation survey one should have a modest plan that can be followed under intensive conditions of precision at all stages of work. Usually it should be sufficient to select at random 1% of the census EAs to be re-enumerated exhaustively on a simple questionnaire using the same concepts and definitions followed during the census. A circular systematic sample of EAs selected from a list where the EAs have been serially numbered in a spiralling fashion in each province, is expected to give a representative part of the population of the country.

13/ Use of sampling in population and housing censuses, ST/STAT/23

14/ ST/STAT/23

39. The UN recommendation made during the Seminar on the Organization and Conduct of Censuses of Population and Housing held in Addis Ababa in June 1968 has been that the reenumeration should be done as soon as possible after the census day. It has also been suggested that care should be taken in interpreting the results of any post-enumeration check and that all discrepancies found between the census and the post-enumeration checks should not automatically be considered as errors in the census. 15/

40. Mauritius (1972), Gambia (1973), Sudan (1973), Libya (1973) and Congo (1974) did not have any plan to conduct a census evaluation survey following the census 16/. Nigeria (1973) is presently arranging an evaluation survey, whereas Liberia (1974) has already conducted one. It is interesting to note here that the preliminary results of the PES in Liberia has indicated that there was 8-10% under-enumeration in the census 17/. Of the countries which are going to take their population census in 1974 and 1975, Dahomey (combined with demographic survey), Ivory Coast, Niger (combined with demographic survey) and Senegal have already made plans to conduct a census evaluation survey after the population census. Some other countries may make the same plan at a later date.

41. It may be possible to check census enumeration results against records obtained during the preparatory work, in particular during a pre-listing of houses and households if it can be done. This has been found very useful in Sudan in the enumeration of the nomadic population where a pre-listing of tribes and clans along with the estimated number of households seems to be almost indispensable.

15/ Report E/CN.14/CAS.6/7

16/ Census dates in brackets.

17/ United Nations Census Adviser's monthly report for May 1974.

VI. FIELD ENUMERATION PLAN, RECRUITMENT AND TRAINING OF FIELD STAFF

Some characteristics are common to most countries participating in the African Census Programme.

- No general population census has ever been taken in these countries. Administrative counts are undertaken at periodic intervals, however, these were organized according to different standards. Thus national authorities lack experience in the planning and the organization of general population censuses.
- The ratio of educated population to the total population is low. Thus, census organizers are obliged to adopt the direct interview method of enumeration. Available manpower which can be recruited as enumerators and controllers is also scarce. Some countries decided to take de jure census because this type of enumeration could be accomplished with a smaller number of enumerators.
- In most countries, public transport and government vehicles are scarce, and density in populated areas is low.

1. Recruitment and training of field staff

The policies and procedures followed for the recruitment and selection of field staff usually involve high-level government officials of the other government agencies (usually the Ministry of Education, the Ministry of Agriculture) to seek their cooperation in making employees available for the enumeration period. After negotiations are undertaken, agreements between census directors are usually made official by census committees which also determine the date and duration of the enumeration, sometimes according to the type of field personnel to be employed during the enumeration period.

Type of field personnel

The following table shows the type of personnel used as enumerators and controllers:

- The staff of national statistical offices is barely enough for current work

In most countries enumerators and controllers are school teachers. This has several advantages:

- School teachers are usually trusted by the population. Communications between the respondent and the enumerator are easy to establish.
- School teachers usually know the area in which they are assigned as enumerators, specially if these are also their area of residence.
- School teachers' handwriting is usually easy to read, the data conversion and capture would thus be facilitated.

- Teachers are also in charge of yearly school population censuses which are conducted in many countries. Thus, they are used to filling out questionnaires, properly to collect information on occupation, on age, etc.

Many countries like Dahomey, instead of using school teachers who are available for census work during long holiday periods, employ students or unemployed educated people as enumerators. Some other countries in order to complete enumeration in a relatively short time (for example Upper Volta), will recruit teachers as controllers and other persons as enumerators.

The main drawback in using school-teachers is their limited periods of availability. Their training period and the enumerations usually last three weeks. This implies either choosing summer vacations (which is not a favorable period for field work) as the enumeration period, or modifying school calendars in order to organize enumeration during Christmas or Easter holidays. Most statistical offices (or national census offices) are not influential enough to obtain from Governments modifications of school calendar.

Training of field staff

A country with 7.5 million inhabitants would need about 6,000 enumerators and 1,200 controllers. It has in its statistical office 10 trained statisticians. It is clear enough that enumerators and controllers cannot be trained by statisticians even if it gets 100 statisticians, of which 50 can train other people.

VII. DATA PROCESSING

A. Planning and organization

1. Current advice emphasizes the potential of the computer for producing timely census results. This potential can only be realized by suitable management, otherwise delays can be longer than if there were no computer. Some constraints are imposed on processing at a very early stage - choice of the method of data capture, design of the coding system, and above all the physical lay-out of the questionnaire. From this point onwards census data processing constitutes a complete project, with objectives, inputs, resources, procedures and outputs. With untried resources and procedures the project is inevitably one of high risk.

Thus there are two major problems. The first is associated with questionnaire design. The second is one of project management.

2. The whole design of the questionnaire becomes of critical importance when a computer is to be used to process data. As always the first aim of the questionnaire is to obtain information. But now we are much more concerned with transmission, interpretation, transcription, filing, retrieval and correction than ever before. Effective advice from operational staff is crucial for success. Unfortunately this is often hard to come by, sometimes even harder to evaluate.

3. It has been pointed out many times how important planning becomes when the computer is involved. Certainly the initial constraints mentioned above are critical for the processing operation. But it must also be said that, following this, while good management can make a success even of weak plans, good plans will always be ruined by poor implementation.

4. The processing project manager needs to have the confidence of the subject specialists, preferably based on shared knowledge and experience. He must also be able to speak the language of the data processing staff. Computer systems training would be ideal. Unfortunately this usually takes far too long. This appears to be a special training problem.

5. It is to be noted that effective project management from within the census organization becomes even more important when the organization makes use of a separate computer department.

6. The project manager's job is an administrative-technical one. He needs access to new kinds of information outside the usual statistical fields. For success he must be able to secure rapid lasting decisions on many points of detail. Such requirements are not well suited to many statisticians, trained to reserve judgement rather than give it readily, particularly in areas where experience is limited.

B. Coding

7. Although this subject has been discussed earlier the computer programmer will want to emphasize certain points. Code series must be checked at input for validity. A series which can be described entirely by the lowest and highest values, with no breaks in between, is obviously the easiest to deal with. There is an even more important consideration.

When tabulations have to be specified it is far easier to locate each cell if the code series is continuous, so that the location can be specified by formula. This forces the programmer to bring every code series under control, translating it to the continuous series required.

8. It is sometimes overlooked that the computer can easily select ranges from a continuous series, unlike card-processing which must rely on digit positions. Surprisingly the most ill-adapted coding is produced by statisticians who seem persuaded that significant digit coding offers advantages for classification. A four digit system is often produced to describe fewer than a hundred different categories. Whatever the external advantages such systems may possess they present only disadvantages to all forms of computer processing.

9. Using a continuous internal coding system the computer can easily assign whatever external coding is desired, however discontinuous, using a 'look-up' table. Unfortunately the inverse operation is many times slower and more complex. Accordingly if special codes are needed in reports these should be prescribed only when needed.

10. In the light of these considerations it is strongly recommended that the code designer should help the programmer (and himself) by offering external code series which come as close as possible to the continuous series which the programmer must arrange within the computer.

11. In addition to the points above the attention of the code designer must be drawn to the role of coding in the verification process. Many code systems would be radically recast if potential verification and correction procedures had been studied in advance. For this reason it is recommended that where possible full computer verification and correction procedures be used for the pilot census, giving close attention to the recommendations of the systems expert for coding changes to be made in the final census plans.

C. Data capture

12. Existing recommendations regarding data-capture need some revision in the light of advances made in the past three or four years. The results of actual work done in this field relating to census operations from 1970 onwards do not appear to have been fully documented, correlated and analysed for the benefit of new users.

13. Requests have been made by Statistical Offices in Africa for up-to-date detailed study of data-capture methods for census processing. The demand is logical but cannot easily be met from the resources of the regional advisory service. Such a study would need to concentrate on planning needs, levels of accuracy, correction procedures and particularly on human resource requirements and time scales, much more than on estimated costs (which in the event are often miscalculated). Special notes are needed regarding supply and maintenance facilities within individual countries.

14. Despite the difficulties evaluations of the type suggested are critically important. Decisions on data capture have to be made before or at the time of questionnaire design. The choices made have a distinct effect not only on the design itself but on all manual and computer pre-tabulation processing.

15. A special problem in certain parts of the African region is the low rate of key-punching attainable under local conditions. More than twice as many operators are required to complete the work in the same time as would otherwise be expected. In addition key-to-tape recording equipment is difficult to maintain where there are high levels of dust, humidity and heat. This makes it difficult in many instances to replace older punch-card units with newer and more efficient equipment. Optical readers can help to solve the problems in particular cases but this places even heavier demands on the need for effective planning with expert advice.

D. Data input problems

16. The biggest single problem at present is that there is no computer software package for data input and verification corresponding to the various tabulation packages now available. The procedural problems are mainly related to correction philosophies and the management of manual amendment.

17. Manual intervention in correction procedures is frequently specified:

- When geographic or other identificatory coding is wrong, and the context does not assist corrective action.
- when records are missing or where a record is so defective that it is beyond the scope of logical or other correction rules.
- where the volumes of correction indicate the need for a thorough coding review.

18. In some cases manual correction is assigned to the data recording section when the errors are substantially due to incorrect transcription. (This question arouses controversy, sometimes not easy to resolve).

19. The organization of manual correction can be critical for planning. A poor system can extend the time needed for input many-fold, jeopardising the time-table.

20. Standard recommendations for automatic correction of census data have been called for more than once. The difficulties here reside mainly in suiting the recommendations to different correction 'philosophies', to differing data content, and different code designs.

21. In most cases the 'philosophies' mentioned above reduce simply to attitudes. In a few countries there is a bold policy of avoiding manual intervention at all costs. Such over-reliance on the computer introduces certain risks. For examples the replacement of missing records may be acceptable subject to suitable controls. Without these there is the danger of unknown bias in results.

22. A far greater problem is over-caution. The real uses of census aggregates for policy-making may be overlooked. Procedures based on administrative routine are often employed, achieving little or nothing for the statistical objectives. Resistance to automatic correction is sometimes due to difficulty in making decisions, sometimes to lack of assurance that the computer will do what is required.

E. Tabulation

23. Portable ^{1/} software packages like COCENTS have gone a long way towards meeting the problems of tabulating census results. Some problems remain. In common with most packages of this kind there are drawbacks. For instance there is no easy way of accumulating partial totals, e.g. province by province. The system for specifying descriptive text imposes a heavy burden. Efficient use is not made of disk storage where available. ECA is indebted to the Bureau of Census for special training facilities in the COCENTS packages but such dependency extending to the specialized job of installing the package concerned, is not altogether healthy, and the arrangement needs to be reviewed.

24. A good deal of advice already offered to statisticians regarding tabulation remain entirely valid. We have drawn attention to the possibilities of computer analysis that can be specified simultaneously with major tables. However some practical hints on the use of percentages, means and medians for example would be valuable at this point.

F. Data Input Operations

25. With the successful implementation and support of packages for table and report generation we can regard the tabulation problem as substantially solved. This draws particular attention to the question of census data input. Four problem areas become apparent:

- (i) The programming system to be adopted,
- (ii) The programming techniques needed,
- (iii) The method of developing specifications,
- (iv) The detail to be included in the specification.

26. General recommendations can be offered for (i) and (iii). In the case of item (ii) a general format has been developed which can be made available to systems analysts. The last item has presented difficulties so far as generalised recommendations are concerned. An earlier attempt to develop model test series based on the 'African' recommendations for questionnaire content proved less than successful. It was discovered very quickly that even when the questionnaire contained the same questions the scope of tests depended significantly on the actual coding schemes employed. Attention has been transferred to providing a library of code schemes, questionnaires and associated test series for censuses already undertaken in the region. These can furnish a useful guide to those who wish to draw up new test series.

G. Data input system

27. It is perhaps useful to make a preliminary comment regarding early summary results. It is not recommended that these should be made dependent on computer operations. Coding and recording of data impose an inevitable delay. The quickest results are most often obtained from totals collected manually at the end of the data collection phase.

^{1/} A portable package is one that can be moved easily from one computer type to another, a long-term advantage. One machine or one manufacturer packages tend to 'lock-in' users to continued use of a particular manufacturer's products.

28. Essential data input operations include translation, error detection, correction and file assembly. Special file operations may be needed to deal with assignment of geographic codes. For discussion purposes this has been regarded as a special and separate operation.

29. It is sometimes recommended that all the operations mentioned above should be carried out in a single phase. Multiple phase is more usual, offering the following advantages:

- (i) Specification, program development testing are easier
- (ii) The first phase can be used to help establish an adequate coding quality assuring the efficacy of automatic corrections made later
- (iii) Tests and corrections requiring the assembly of household sets can be deferred to await completion of sets by amendment and addition followed by sorting.

30. The second phase can be used to eliminate duplicates (by conditional obtain action) detect missing persons, households and sections. It is to be noted that only 'single-record' tests can be applied to individual record additions and manual amendment cases. It is suitable therefore to make tests based on single records in the first phase and tests based on complete household sets in the second phase.

31. Further operations include updating (effecting deletions, replacements, elimination of duplicates), derivation of summary information and merging batch files. These are more or less standard process operations, simple to specify and to program.

32. Detailed recommendations on coding principles constitute a separate subject discussed in an earlier section. Certain general points need to be made however in connection with the data input system. First of all three categories of data have to be distinguished - namely, data at first entry, including rejected data to be re-entered, deletion instructions relative to individual records or groups, and thirdly replacement data. Special note must be taken of the sequence in which these have been placed. Record type codes must allow all these categories to be distinguished clearly (although they may also be used in extension for other purposes, such as differentiating rural and urban areas). Preferably they should also allow for the correct sequence to be imposed without recourse to calculation of internal sequence codes.

33. It is a well established principle that all individuals in the census must be uniquely identified by appropriate coding. But in addition to this all records input to the system, including records relating to the same person, must also be uniquely identified. Note that there may be more than one record, in any of the three categories quoted, for one and the same person. In the first of these categories multiple records should only occur accidentally, incidentally introducing the special problem of how to treat two first entry records for the same person which are not absolutely identical. Apart from this special case the problem reduces to imposing a sequence, usually latest entry first after category sequence.

H. Designatory item tests

34. Designatory items consists of geographic codes other than area 'status' codes unless these affect code sequence, household numbering and person numbers. There may be other special designatory codes distinguishing record type, amendment action type if shown separately, and amendment serial number and/or run number.

35. Among these the items to be specially considered are those which serve to identify the individual. If such items are suspect at the beginning we have little chance of locating the record concerned in order to effect a later amendment, not to mention the implied tabulation error. However at initial input we have some opportunity of rectifying lesser defects. Where a strict sequence has been enforced in questionnaires, for instance, we can reasonably guess that a person number sequence of 6,6,8 should be corrected to 6,7,8.

36. If all other sequence conditions are in order but one of the designatory codes is unacceptable in the middle of a set of three records then correction can reasonably be attempted (but should be reported). A further simple correction is to assign person number one if the person number is missing or unacceptable for the first person in the household, shown as the head.

37. Apart from such obvious cases it is dangerous to accept records where essential identification is missing or invalid. Such records should be **rejected** and the resulting report should draw special attention to the rejection distinguished clearly from all other types of report.

38. If card input is used (or direct key-to-tape, where there is no facility for inserting skipped records in correct sequence at verification) it is unsafe to rely on sequence. It must also be remembered that individual additions and replacement records can appear almost randomly. This is why processing on a single-record basis is to be preferred at this stage. The situation is obviously different at later stages when amendments have been inserted and the file has been sorted.

I. Translation

39. The notes below apply to the ordinary translation required from external to internal codes, apart from special processes which may be required to deal with geographic codes. For both translation and test procedures the specification should be tackled systematically. For this reason the recommendations are set out as a series of steps.

40. First list the record items as they will appear in the input record, assign abbreviations to be observed throughout the specification, note the highest code value for each item and note all acceptable non-numeric codes, including blank if appropriate.

41. Set out translation rules for each item according to the following principles: Translate acceptable numeric codes as received. Translate out-of-range numeric codes to a separate error code value. Translate acceptable non-numeric codes to an assigned numeric value. Translate unacceptable non-numeric codes to the assigned error value. In 'conditional-entry' cases (e.g. to be completed only by females aged 12 and above) translate blank to a separate numeric code, although at this stage there is no certainty that blank is actually acceptable. The assigned code should be easy to recognise.

42. Look for cases where derived values are appropriate. For example a code pair 'Month/Year indicator', and 'Number of months or years' would probably be better translated to an internal code pair 'Years' and 'Months', allowing error codes and non-determined codes to appear within each.

43. The translation rules can be assembled in tabular form with column headings:

(i)	Item		
(ii)	Numeric:	From	(a series of ranges may be specified)
(iii)		To	
(iv)		Else	(Error code translation - to be reported)
(v)	Non-numeric:	If	
(vi)		Then	
(vii)		Else	(see (iv) above)
(viii)	Derivation rules if any, or other special notes		

J. Test series

44. As a first step towards drawing up a test series it is preferable to set down in tabular form, but in plain language, all the logical relations for consistency that can be discovered, including even those where the relation is probable rather than completely logical. The less certain cases can be marked for later review. It is easiest to begin with conditional-entry cases, such as the required entries for females aged 12 or more in fertility items. It must be remembered however that the tests concerned do not necessarily come first in the test sequence to be adopted eventually.

45. The next step is to review cases where 'non-determined' is not acceptable. (In all other cases the error code value will be associated with the 'non-determined' code or codes.) Correction rules must be devised for these cases, first according to logical rules, alternatively by high probability, and failing all else by stochastic rules. Extra notes on the latter are added below.

46. It is necessary to distinguish carefully between tests (and corrections) based on a single-record only, and those demanding the context of the household record set. As a first step in arriving at a suitable sequence the tests should be ordered according to the sequence of items in the questionnaire where this item, but not earlier ones, is involved in the test concerned.

47. Tests leading to stochastic corrections need priority in the test sequence. A stochastic correction can produce new inconsistencies, requiring a re-cycling of tests. Clearly such re-cycling must be reduced to a minimum. The logic of the whole set of stochastic corrections must be checked thoroughly to guard against the danger of endless re-cycling.

48. Finally the test series, both first stage single-record based, and second stage household set based, must be checked for redundancy and contradiction. Test sequence may be of critical importance. Fixed rules are sometimes recommended regarding priority, e.g. it is sometimes recommended that age be settled before sex, sex before marital status, and so on. However a good deal depends on the questionnaire content and coding design. Such 'rules' must therefore be treated with caution.

49. For the sake of subsequent data quality analysis arrangements should be made for three distinct code values in the non determined category

- (i) Reported at input as not-determined
- (ii) Error input
- (iii) Corrected to not-determined by program.

K. Stochastic correction-criteria

50. The principle of stochastic correction is that results are unaffected if missing items are assigned according to the probabilities indicated by the relative proportions of valid items. The practical operation is to find record with characteristics closely similar to the record containing a missing or unacceptable item, making the corresponding items the same. The probability of assigning the value found is related to the probability of finding the same characteristic set. The argument of 'local' probability is also invoked, e.g. if occupation is missing among a series of farmers the missing occupation should be taken to be farmer as the most likely. These remarks are of course merely comments. The practical problem is to preserve information about 'similar' classes in as economic a fashion as possible during processing.

51. A good deal of interest centres on the question of bias arising from stochastic correction. This can result from prior correction according to logic or probability favouring certain attributes disproportionately. For instance it may be easier to assign sex as female using logical rules than to deduce that the missing sex is male. If the residue are assigned randomly half and half to male and female there may be bias. Obviously this can only be significant if the proportion of corrections made is high in relation to valid items. There is equally a chance of inherent bias in the missing items themselves.

Male may be reported accurately while female is reported indifferently. The general rule is that the overall quality of reporting should be assured at a reasonable level before resorting to stochastic correction. Alternatively we must think in terms of accepting a non-determined category.

52. If need be the use of stochastic correction can be regarded as a last resort when all other correction methods are unavailing and a specific attribute must be assigned. The paramount consideration is the needs of tabulation. In certain cases non-determined has no logical meaning. In other cases the item is a major classification criterion, e.g. sex. If omitted then a considerable amount of other information would be lost.

L. Stochastic correction-examples

Sex

53. The simplest stochastic correction relates to sex. Where this is missing it is usually sufficient to assign sex as male or female alternately (after all the logic and probability rules have been exhausted).

Household status

54. Many questionnaires distinguish between normal and institutional forms. Non-determined is not usually acceptable. A test can be based on relations to head of household, expected to be radically different in collective groups such as hospitals. It is recommended that where the requirement for this correction exists then the coding of head-of-household relation should be extended accordingly, e.g. to provide specifically for membership of collective households. This is only one of many examples where coding design can aid verification and should be arranged accordingly.

Residential status

55. Respondents are commonly asked to show whether they are resident, normally resident but temporarily absent, or whether they are temporary visitors. No other categories are admitted. Some logical deductions are available from other entries where these are restricted to residents. If no logical deductions can be made in this way a stochastic correction should be made. The simplest is to copy the status of the previous person. Such correction can be made on a single record basis, presuming that the previous record is left in store.

Economic activity

56. Frequently the basic economic activity categories do not admit a non-determined category. There is no fixed method of tackling this problem, although many surrounding items will be found to furnish evidence, either logical, or of known probability. It is dangerous to use the simple previous person rule because of the strong effects of age and sex. It is better to use a previous person rule modified by age and sex divisions. Four divisions may be adequate for this purpose, that is, a double age division, one for each sex.

Age

57. Age corrections are usually restricted to large forms in a final census. They are sometimes used in pilot surveys on an experimental basis. It must be pointed out that, from the programming viewpoint at least, automatic age correction is not simple. Moreover when procedures have been devised they require to be tested very thoroughly, which is not as easy as may be supposed. Stochastic corrections are based on the principle of finding suitable categories available within the household set of questionnaires. Common categories used in age correction include the following:

- (i) Infants less than one year of age -- (age stated in months)
- (ii) Males below economic age limit
- (iii) Females below fertility age limit
- (iv) Students/Persons seeking first employment (Distinguished if appropriate)
- (vi) Junior to Head-of-household relation -- Age difference

- (vii) Junior to Wife-of-Head relation - Age difference
- (viii) Other persons - Ever-married
- (ix) Other persons - single or marital status unknown.

The ages (or age differences) are stored for the last detected case of each category within each household in turn where no query arises for the category concerned, to be applied where necessary in the succeeding household. In the age-difference cases the correction is available for either party in the relationship.

Initial values

58. It is necessary to set an initial value for all stochastic reference sources. This may be arbitrary e.g. male, or else estimated from prior probability.

Markers

59. It is recommended that records contain markers showing where and for which items automatic correction has been effected other than to the non-determined category. If at all possible separate markers should be included to indicate stochastic correction.

VIII. PROGRAMMES OF ANALYSIS OF CENSUS DATA

1. If census data and analytical studies are to be used in development planning, they should be tested for accuracy and corrected so far as is feasible. The tabulations must undergo detailed study prior to publication for the purpose of identifying and correcting errors and inconsistencies.

2. This part of the report will be presented under two sections: Critical review of census data, Programmes of analysis.

A. Critical review of census data

1) Various sources of errors in African census data

3. As many African countries will undertake for the first time their general population censuses, many errors which are detected in the analysis of the tabulated data can be traced back to errors which occurred early in the project. These errors are often classified as either sampling errors or non-sampling errors. The following recommendations will limit themselves to non-sampling errors which can be grouped as follows:

- omissions and duplications in coverage;
- content errors and other types of errors committed in the preparatory phases of the censuses;
- various processing defects.

a) Omissions and duplications

4. Inadequate mapping may lead in omissions of entire areas in African censuses. Other types of omissions arise when complete enumeration areas or urban housing units are overlooked. In order to avoid this type of omissions or duplications, mapping has to be achieved properly, it has been often demonstrated for example that lists of villages established by Ministries of Interior, Ministries of Finance are mostly inadequate for census purposes. In many countries of west Africa, aerial views of urban areas which had been made 1-2 years prior to census date have to be completed by new area mapping.

5. Even if mapping had been carefully executed, field control is essential. Moreover, it is recommended that census offices keep at the national and the sub-national levels complete listings of all enumeration areas, and localities. Census figures, even provisional ones, cannot be published before comparisons between those listings and geographical data collected in the field by enumerators and supervisors. Within household under-enumeration (or over enumeration) is not studied here. It is presumed that analysts deal with this question at a later phase. (Young Adults are missed because they frequently migrate, infants and older persons are missed because they are frequently forgotten).

b) Content errors and other types of errors committed during the preparatory phase of censuses

6. These errors can be summarized as planning errors, errors in questionnaire design, errors during training of enumerators, interview errors and enumerator errors.

7. Errors in the contents of questionnaires are rare, since most countries follow closely international, African and ACP recommendations. However, in a mass operation, standardization of question wording and response categories will minimize errors. Questionnaires should also be designed in order to make it as comfortable as possible for the enumerators to record each response accurately. This question has been often overlooked in many African censuses; some countries have adopted questionnaires which are at the same time too bulky and in which spaces reserved for recording responses are too small. It should be remembered that in African conditions, enumerators often have to record responses in standing positions. Therefore, questionnaires should take into account enumerators working conditions as well as processing needs.

8. Errors committed during the training of enumerators and by the enumerators in the field often become clear at the critical review phase. In some cases, written instructions to supervisors and enumerators are either too short or unclear. Thus, instructions given by sub-national and local supervisors to enumerators are often heterogeneous. It is therefore recommended that (in African countries which often adopted the two or three-tier training scheme) in addition to enumerators' manual which should be kept simple and clear, detailed manuals be designed and written for supervisors in charge of training. Training materials have to be homogeneous throughout the country, and should be as explicit as possible.

c) Processing defects

9. Processing errors occur in clerical work, editing, coding, data entry or tabulation. The extent of these errors vary over a wide range. The most common which appear on tabulations are errors in coding. Responses, on occupation, industry and relationship to head of household are often improperly coded. It is therefore reminded that coders should be properly trained and constant supervision be made during pre-computer processing. The writer of this report has noticed several times that in countries which use teachers as enumerators, data collected in the field is usually good on occupation, but coding in statistical office is often very poor, therefore resulting in a considerable loss of information.

2) Procedures to be taken and types of checks to be made

10. Modern computers, when properly programmed, rarely produce erroneous data. It can be said that most errors occur at early phases of census operations and during the analytical process. Census analysis cannot be well performed if researchers are not aware of census design, concepts, field instructions, coding instructions, etc. It is therefore recommended that continuity of staff be achieved. At the analytical phase, a short methodological report should be published before census data are given to government ministries, universities, research groups, since the analysis of most African censuses are too time-consuming for the staff of statistical office alone.

11. Two types of review should be performed, the mechanical review and the analytical review. Recommendations concerning analytical review will be treated in the later part of this report, together with proposals on programmes of analysis.

12. Mechanical review consists mainly in checking relationships in the data: categories in a distribution should add to the total, categories that appear in several tables should agree. Mechanical inconsistencies are rare with modern computers associated with good programming. However, even computer printed tables should be checked. Instructions concerning mechanical review of tables should be developed by data processing and subject specialists. It is not possible, within this report, to give the census expert or the analyst precise recommendations, but checks between tables and within tables should be carried as far as possible. All tables contain totals or sub-totals that appear in other tables. For example, the number of married women by age groups always appear in tables on marital status, but also in tables on economic activity, occupation, levels of education, number of children ever born, etc.

13. Other types of review should be performed: review of the tables for logic, common sense, review by comparison with data from other sources. This type of checks will be reminded in the later part of this report.

B. Programmes of analysis

14. Censuses conducted within the African Census Programme must be regarded as long-term investments, as the collected data will make important contributions to policy-making and demographic research for at least a decade. Data will be however to certain degree, dated products, unless some urgency is attached to publication of results. Thus, recommendations* made in this report take into account:

- Censuses have been completed, or will be soon conducted, in many countries. In 14 countries participating in the African Census Programme, censuses are being taken for the first time. New opportunities are therefore created for research on the characteristics of the population. In other countries, the information from the new censuses combined with those from earlier enumerations will greatly enlarge research facilities. The information supplied by censuses will be plentiful. Yet, in most of these countries, demographers with wide experience of census analysis are rare.
- Although demographic studies need not be oriented toward policy formulation, recommendations made in this report is primarily directed toward policy-making and action. This seems to be the prevailing point of view in many African countries.
- It is not the purpose here to provide specifications for studies in any one country. The selection of questions to be investigated and details of the methods must, of course, be adapted to the needs of each country.
- Taking into account priorities set up by governments, the scarcity of available manpower for demographic analysis, the wealth of data supplied by censuses, the time-consuming nature of detailed analysis, proposals concerning the organizational on analytical work will be made at the end of this report.

15. Suggestions regarding analysis of African Census data will be presented as follows:

* During his assignment as the Regional Demographic Adviser of the African Census Programme, the writer of this report had to devote all his time to country missions and their follow-up work. Thus, this general report, which was written during a few short weeks before taking up another assignment, should be considered as a working paper.

- Section 1: Size, distribution of the population and internal migration;
- Section 2 is concerned with studies of population growth and structure;
- Section 3 covers suggestions on studies related to cultural characteristics of the population;
- Section 4 is concerned with manpower studies;
- Section 5 deals with studies on the numbers of households, their size, the characteristics of households;
- Section 6 proposes some measures on organizational problems related to analysis and publication of census data.

16. The indications given below are not detailed, the analyst who need detailed and complete prescriptions should refer to UN demographic publications, specially to "National Programmes of Analysis of Population Census Data as an Aid to Planning and Policy-Making" (ST/DOA series A/36, sales No. 64 - XIII.4). This document although published in 1964, is still an excellent guideline on analysis and utilization of census data. This report limits itself to propose priorities and the type of studies usually requested by African Governments for planning and policy-making.

Section 1: Size and distribution of the population, internal migration

17. Among all data collected in censuses, the number of persons in a country and in each of their administrative division and subdivisions are the most widely used and criticised. Therefore, before any publication, even provisional, the number of persons of all geographic and administrative divisions and subdivisions should be revised with data from other sources. Needless to say, previous censuses should be used for this type of analysis. Even in the fourteen African countries which have conducted or will conduct in 1975-1976 their first general population census, administrative counts had been made at regular intervals. These counts, which were usually undertaken for fiscal purposes seem often better than most analysts would agree. In any case, it is suggested that census population figures be compared with existing figures for all administrative divisions and subdivisions. If some figures seem suspect, evaluation surveys should be undertaken in the concerned areas, before any census figure is released.

18. In making this type of comparison, the analyst has first to assess whether the source data are reliable, if not, it is useless to make the comparison. It is also recommended to determine whether the concepts used in the administrative counts are similar to those used in the census. Administrative counts usually rely on the concept of family than the household. It is equally important to make sure that administrative boundaries under comparison are the same.

De facto and de jure counts

19. In many African censuses, population count is based on the usual place of residence rather than on the population physically present at the time of the census. These enumerations fall within the concept of de jure population. However, the procedures used in most of these censuses make it possible to derive de facto counts, both for the total population and for the population of administrative subdivisions. This required coding of all enumerated persons by status of residence. For some types of data, it may prove necessary in some countries to set up two sets of tabulations. Because of important migratory movements in and between west African countries, differences between the de jure and de facto counts may be very large. If both types of data are published, it is necessary to give details

on procedures of enumeration, on enumeration dates. In addition, recommendations should be made on the use of each type of counts.

Spatial distribution of the population

20. The extent to which people of a country are concentrated in some parts of its territory has important economic and social implications. This is specially true in countries like Chad, Mauritania, Mali, Niger, Sudan, etc. Tables giving population numbers by administrative divisions should be analyzed in relation to total area, area of cultivated or cultivable land.

21. Tables giving the density of the population by administrative divisions and subdivision should also be published and commented. It is recalled that density figures at the smallest administrative divisions are the most useful ones for policy-making and planning. Decisions on location of schools or hospitals, and generally of all the social structure cannot be made if some census data are not properly analyzed. For example, in two provinces of a country, population density is 20 inhabitants per square kilometer in province a and 0, 1 inhabitant in province b. The analyst may prove that given the same school enrollment ratio, school expenditures per head are much lower in province b than in province a. Province b is mainly district; population is concentrated in localities ranging from 500-4000 inhabitants. The primary school system is thus viable in the province. In province a, population density is relatively high (for the country), but census published data give population figures by village, which are administrative units rather than agglomerated areas. In effect, rural population is scattered all over province a, in small farms relatively distant from one to another. Most localities count 75-300 inhabitants. The analyst may show that multi-classes elementary schools are too costly to run in province a, and that most schools will be empty, because of the distance to school for the majority of children. Given these information, the educational policy-maker may decide that in province a, a network of one-class schools will be organized. Children aged 6-10 of a same small locality and its surroundings will receive their elementary education in the same class room with the same teacher.

22. The example shown above may seem extreme, but similar situations exist in several African countries. Studies on spatial distribution of the population are often neglected by government offices in charge of census analysis. These types of studies have of course to be adapted to country needs and problems. In doing so, many social expenditures will be more rationalized, and the situation in which schools are empty or hospitals overloaded, or under utilized post office may be avoided.

Separate analysis of the urban and the rural population

23. In African countries, urban rural contrasts are so marked that separate analysis is necessary. Several countries participating in the African Census Programme had even considered to use long forms for the urban population and short forms for the rural population. Long forms usually contain additional questions on education, place of former residence, industry, housing conditions

24. Before embarking in separate analysis of urban and rural population, the analyst should precise the definition of urban population since in most African countries, rural population is defined as contrarious. Urban definitions used in African censuses fall into these groups:

- the number of inhabitants in the agglomerated area;
- presence of the administrative function in the centre, administrative status of the centre;
- presence of certain urban characteristics in the centre.

Increase of the urban population

25. The increase of urban population in most African countries has been very rapid in recent years. Although the writer should not have made this type of statement without precise figures, it can be safely said that estimates rates of growth of the urban population had been seriously underestimated in current publications. This assertion is based on:

- administrative counts periodically undertaken in cities of Africa, specially in West Africa;
- acceleration of migration from rural to urban areas in recent years; in some countries, this was due to the drought;
- natural increase of urban population may be even more important than expected.

Thus, studies of the increase of the urban population with census data should therefore be detailed.

26. It is suggested that the following tables be given priority:

- population of urban agglomerations by place of usual residence, place of previous residence, age and sex;
- population of urban agglomerations by duration of residence, sex and age;
- population of urban agglomerations by place of birth (same place, other agglomerations grouped by large administrative divisions, rural areas grouped by large administrative divisions, other) sex and age;
- population of urban agglomerations by duration of residence and occupation (broad groups).

27. If enumerators are reasonably trained and pre-computer processing achieved properly, data included in the above tables are better than usually assessed by demographic statisticians. At least they are good enough for studying and charting trends.

28. Studies on the increase of urban population have to state changes in administrative boundaries of urban agglomerations. In many African countries, rural areas adjoining to cities have become densely populated and acquired urban characteristics and therefore were incorporated in urban agglomerations. Thus, it should be underlined that analysis changes of boundaries should not hide rapid urbanization. Comparisons made between censuses (or between an administrative count and a census) should have the same territorial base, preferably the urban boundaries of the latest census.

Migration between rural areas

29. Although migratory movements between rural areas is important in some African countries, their study is often not possible, since for the rural population most censuses include only questions on places of birth. Data on places of birth give indications of the magnitude of migration and the origins and destinations

of the migrants. But, dates of the movements cannot be ascertained. Furthermore, a person found in an area may have migrated several times between his place of birth and his enumeration area. This is specially true for the so-called "floating" labour force enumerated in many areas of West Africa.

30. Although data related to places of birth cannot give precise information on migratory movements, it is recommended not to overload censuses and general demographic surveys with questions like migration histories, duration of residence in successive places, reasons for migrating These information can be obtained only through specialized demographic surveys.

Other suggested studies

31 The list of studies reviewed below is simply a reminder for demographers in charge of analysis:

- population of localities by number of inhabitants in relation to the distribution of manpower;
- comparative density studies using ratios of total population to area of cultivated or cultivable land;
- characteristics of migrants by sex, age, educational level and occupation;
- characteristics of heads of households (enumerated in urban agglomerations) by duration of residence and occupation.

Section 2: Studies of population structure and growth: Sex and age, fertility

32. Analyses on the components of population growth and structure deserve high priority in a programme of studies based on census data. The reasons are multiple:

- levels of accuracy on age and sex should be assessed before further analyses on various economic and social data;
- they provide the basis for population projections for the analysis of problems of manpower, education, housing, household formation, etc.

33. In summary, studies of population growth components and structure provide essentials for all types of further analyses and calculations.

Studies on sex-age structure of the population

34. The classification of each person as either male or female is simple. Reporting errors are rare and can be ignored. When errors are manifest in the tabulated data, they are caused almost entirely by errors of coverage, that is by the net under-enumeration of persons of one sex of certain age-groups. In African censuses, under-enumeration occurs frequently for older women, infants, live-in-servants (mostly because of the confusion between household and the family). Although this type of under-enumeration is often underlined, it seems to the writer that this type of coverage error is minimal in comparison to others.

35. The basic tool is the sex ratio, which should be calculated for all administrative and geographic divisions of some importance, major cities, provinces, countries, "cercles", "departments", "arrondissements". If sex ratios appear to be "wrong". The main possible explanations are:

- field oral instructions which may vary from one administrative division to another;
- in many African censuses, sex ratios depend vastly on the time chosen as census reference date, whether the de jure or de facto population was chosen for inquiry and tabulation;
- heavy in or out migration from an area.

36. Age is perhaps the single most important variable to analyse in African census data. Almost all population characteristics are related to age (among others, activity rates, fertility, mortality, marital status). It is essential in all types of demographic analysis to take into account the age factor. Yet, age is among the most questionable data in African censuses.

37. Special precautions should be taken before and during the enumeration, both on the interviewer and the interviewee sides, to insure that statements on age is the closest possible to actual age. Once the enumeration is over, and data are processed, evaluative techniques can, among other things, correct under-enumeration at certain ages, can rebuild the age pyramid; however these techniques cannot correct, for a person or a group of persons their other characteristics related to age. Automatic corrections at the data processing stage also have their own limitations.

38. It is not possible within this report to summarize all types of analyses and analytical technique related to ages, researchers on African census data are referred to specialized publications. Following is a list of priority studies to undertake before the publication of detailed data.

- selective under-enumeration of infants and young adults;
- accuracy of age reporting, attractive age, misstatement of age by women, by older persons, reporting as one year old of children under 1 year old (the same observation applies to all durations of less than one year, duration of residence, of absence, duration of unemployment);
- influence of internal migration on the age and sex structure;
- in countries like the Ivory Coast where immigration is important, it is essential to tabulate data on sex and age separately for the native and the foreign born population. Actually, analyses cited above can be misleading if based on tabulations related to total population.

Studies on marital status

39. It is suggested that these studies be given priority:

- variations of marriage rates, celibacy rates (and sex and age) between censuses or between a demographic survey and the census;
- differences of the same rates in various areas of the country concerned (urban and rural, important administrative and geographic divisions), according to educational levels groups, occupational groups.

40. Studies on polygamy are not recommended; the type of information needed cannot be collected in a census, and analyses based on derived data can be misleading.

Studies on fertility

- 41 - Ratios of children to women of child bearing age, for different parts of the country concerned, should be among the top priority tabulations.
- In most African censuses long questionnaires included information on the number of children born alive to each woman during her life-time and during the past twelve months. Collected data should be analysed thoroughly. In most censuses, data collected on number of children born during the last twelve months are likely to be more accurate than data on total fertility. Questionnaires and field instructions should therefore be designed accordingly, preferably by adding a question on date of last birth (regardless whether it was in or out of the last 12 months).

Section 3: Studies on Educational and Cultural Characteristics1. Studies on educational characteristics of the population

42. Great importance is attached to education and schooling in development programmes formulated in African countries. Since the early sixties, due to increasing investments and a widespread policy of mass education, the schooled population has increased at accelerated pace. Census undertaken in the period 1966-1975 will record societies in transition. Educational characteristics are changing, influencing all other aspects of African societies.
43. The following tabulations and related studies should be given priority:
- literacy by sex and age, analysis is recommended by major administrative divisions, urban and rural subdivisions;
 - literacy by sex and age and place of birth;
 - literacy by sex and age and marital status;
 - school attendance by sex and age of the 5-24 years old population. This study should be made for all administrative divisions of some importance (provinces, "départements", countries and major cities).
 - years of schooling by sex and age, for the school population and the ever-schooled (but no longer at school) population. The related studies are recommended for important cities, and major administrative divisions. It would be out of the scope of this report to explain the reasons of such studies, but they would prove very useful to educational planners.
 - highest grade of school completed by occupation (and industry). The proposed analysis should be carried out by type of school; primary, secondary, technical, vocational, higher education, etc.
44. In carrying out their programmes of research, analysts may remind that:
- In most African countries, public expenditures on education range between 20-30% of the national budget. Therefore, it is natural that African governments expect from the censuses detailed data and rapid analyses on educational characteristics of the population.

- Area classifications are of particular importance in the tabulations relevant to studies on educational characteristics. However, some tabulations need not be very detailed. For example, the segment of the population which received higher education is usually located in main cities and administrative centres. It is therefore useless to undertake similar analyses by administrative divisions. On the other hand, even though some data collected in the census undertaken in the seventies are not significant, they should be tabulated, for future inter-censal comparisons. Although similar recommendations can be also made for most studies based on census data, the writer is of the opinion that in African countries, the most significant changes which will occur between the sixties and the eighties will be recorded in the educational characteristics of the population.
- In many African countries, the school population is enumerated at the beginning of each school-year. Therefore, statistics of school attendance compiled by departments in charge of education may differ from census data. Quality of both types of data should be of course assessed. Discrepancies stem mainly from: difference in the date of reference, drop-outs (which may be important in rural areas) between the beginning of the school-year and the census date; multiple counts (for example the children who attend at the same time modern and Koranic schools are counted by both institutions, while they appear only once in the census, students who attend several institutes of higher learning are often counted several times but only once in the census).
- It is desirable to consider variations in literacy, in educational level by sex and age, since mass education has started recently in most African countries.
- In urban areas, data on literacy do not sufficiently measure the educational characteristics of the population. It is therefore suggested to use the percentage of persons who have attained a certain level of education. The percentage of the economically active population who have completed elementary school seems a good tool for the analyst. The median number of years completed is a simple method for comparing educational attainments of different groups.
- Studies cited above will be necessary not only for assessing the situation at the census date, but also for making projections of future educational levels..

2. Ethnic and cultural characteristics of the population

45. Several African censuses included in their forms questions on ethnic groups and language groups. Language is so closely related to the total culture of the people that it can be accurately used as a basis for classifying population into ethnic and cultural groups. At the present time, it seems that studies on the ethnic distribution of the population are not usually given priority by African policy-makers. Therefore, the list of the tabulations listed by the "African Recommendations for the 1970 Population Censuses" (E/CN.14/CAC.6/1) and by African

Census Programme Recommendations* should be adapted to national circumstances. It is recalled that the "African Recommendations" envisaged the substitution of citizenship for ethnic groups.

46. Although studies on ethnic questions should be kept simple. It is suggested also that wherever possible, all tabulations recommended be achieved, even if no current analysis and publication is given priority.

Section 4: Studies on the Economic Characteristics of the Population

47. Population censuses are the main source for manpower studies. Sample surveys cannot usually give necessary details for administrative and planning divisions; and employment aspects studied by economic surveys often limit themselves to the "modern" sector. Thus, the identification and classification of the labour force by types of activity, occupation industry and occupational status are basic parts of African population censuses.

Priority studies to be undertaken

48. Participation in economic activities by sex and age. Activity rates should be computed separately for urban and rural areas, and for administrative divisions of the country concerned. Differences in these rates can be related to local economic and social characteristics, administrative role of a city, presence of industrial activity, agricultural population density, importance of the "modern" sector, school attendance, educational level of the population, etc.

- Activity rates of women residing in urban areas by marital status and age.
- Economically active population by industry and status. The analysis of this tabulation is not only useful for assessing the organizational structure of the economy, but it is also useful for the study of activity rates.
- Economically active population by citizenship, occupation, age and sex. This tabulation and its analysis are often requested by policy-makers.
- Activity rates by place of birth, age and sex; economically active population by place of birth, occupation, age and sex. Studies of these types are often requested for assessing the economic aspects of internal (and international) migratory movements, for the formulation of policy with respect to programmes of resettlement.
- During recent years, planning agencies are increasingly concerned with the numbers of unemployed and educated persons in African cities. Thus tabulations of the employed and unemployed population by sex, age, educational characteristics and place of previous residence should be made.
- Studies on dependency ratios; variations of dependency ratios between urban and rural areas, between different major administrative divisions should be made.

* Please see "Report of the Third Meeting of the Consultative Group on the African Census Programme", Annex V, E/CN.14/595, E/CN.14/POF/106 of 6 June 1973.

49. Studies mentioned above are essential for determining the size and structure of a country's labour force, and for making projections. As the size and composition of African labour force are rapidly changing, research should be made on the factors on which important changes in the future can be anticipated.

50. In carrying out their research programmes, analysts may remind that:

- Seasonal fluctuations on activity rates are well known, and census date should be selected in order to avoid special patterns which are characteristic of only brief periods during the year. However, in Africa, the choice of census date is more difficult than in other parts of the world. Thus census reports should indicate seasonal effects on activity rates and on the distribution by industry and occupation.
- Data on economic characteristics are usually collected and analyzed only for the population 12, 15 years of age or older, but participation of younger children to economic activities is a fact, widely observed. Therefore, related data should be published and analyzed, since participation of younger children have many economic and social consequences.
- Although they are not considered as "gainful workers", participation of women to economic activities seems to be very high in most African countries. There is no reason to include in the labour force farmers who work only three months per year, and to exclude women engaged in petty trade all year round.
- Some African censuses include (in the long forms) questions on secondary occupations. Data collected may be very interesting. However, the analyst should realize that, for rural areas, responses on secondary occupations vary greatly, depending on census date.
- The international standard classification of occupations does not seem adapted to African needs, specially at the three digit level. Coding based on the three digit level is meaningless and often conduces to numerous errors. It is preferable to use two digit codes, for occupation and for industry. The loss of information by neglecting three digit codes is insignificant.

Section 5: Studies of Numbers of Households, their Size and the Characteristics of Households

51. Census data and demographic analysis traditionally have been based on counts of individuals. However, for many purposes, for example the estimation of housing needs, it is necessary to work with data on the basic household needs. Up to the last few years, data on the characteristics of households were among the last ones to be tabulated. They required special decks of cards, additional coding In drawing his tabulation programme, the analyst has to keep in mind that, given some precautions taken at the preparatory phase, household data can be obtained without additional steps at the pre-computer processing phase.

52. The following tabulations and related studies should be given priority:

- Households by size of household, (area classification: major administrative divisions, geographic divisions which can be assimilated to cultural divisions, important urban centres, urban and rural separate tabulations).

- heads of households by sex and age (broader age groups) by places of birth (or by ethnic groups).
- heads of households by size of households and occupation (broad occupation groups).

53. The above tabulations are not traditionally given priority in analysis programme, but they are often in great demand. Therefore, it is suggested that they be published as soon as they are available.

54. In research work on the above subjects, analysts may remind that:

- differences in the average sizes of households may be found between geographic and administrative divisions. Before drawing conclusions of any nature, field checks should be made to verify whether concepts had been uniformly applied. This type of question should be asked: "Was it the household, the 'compound' or the family which was enumerated in certain provinces?"
- extended families (consisting of several interrelated nuclear families) are often household units in rural African societies. This assertion is often overexaggerated. Therefore, it is suggested, in addition to studies based on the number of persons per household, and the distribution of households by size, that research be undertaken on the frequency and composition of the so-called extended family household.
- in many important African cities, household composition, ethnic distribution, conditions of living, housing needs, etc. vary widely from one section of the city to the other. It is therefore suggested that tabulations be made and in so far as possible analysis be carried out by city sections which are often as populated as some major administrative divisions.
- one-person households, mother family households are rare in Africa, but other types of households receive attention from analysts, they are frequent: workers camp households, boarding-houses, households, roofless households.

Section 6: Organization of Analytical Work

55. The organization of population censuses called for the mobilization of substantial national resources. The analysis and utilization of census results represented the main justifications for such investments, African planning agencies usually use census data in all their activities. But for various reasons, governments had not always made the fullest use of the possibilities offered. Due to the shortage of research manpower and lack of coordination between government agencies, the countries which should draw most heavily on their census data are the least equipped to do so.

56. The organization of research programmes on census data is determined by national possibilities and circumstances. Suggestions made below concern countries with rare qualified demographers, universities set up recently, planning agencies and statistical offices with barely enough staff to achieve current work.

57. With the goal of providing analyzed data in the shortest time possible, say 9-12 months after tabulations are made, the following measures are suggested, at the preparatory and the post-tabulation phases.

Preparatory phase

58. All interested government agencies should be consulted not only at the census design phase, but in drawing plans for the most important analytical studies. Provisional tabulation programmes should be circulated, possible use of each tabulation should be indicated, precisions on area classification should be given. Inter-agency committees should be set up not only for advising national census offices on census preparations, but also on the planning and organization of analytical work. The inter-agency committee would also be responsible for

- maintaining close working relations between the technicians in charge of census operations and those in the interested policy-making agencies.
- for talent-scouting; even the case of the poorest staffed countries, it would be possible to find in government departments qualified technicians assigned to routine tasks; some would be willing to undertake the analysis of census data, in their fields of work. For example, technicians from the Ministry of Education will be assigned to the study of educational characteristics, those from the Ministry of Labour will be assigned to manpower studies.

Organization of analysis and publication at the post-tabulation phase

59. Although qualified technicians can be found for all fields of work, it would seem an error to reunite them in the national census office (or the national statistical office) and create an unit in charge of evaluation and analysis of census data. Inter-agency relations are what they are, no department would let its good technicians go and enrich another department. Moreover, specialized technicians need the support and advice of their colleagues working in the same field. Their analytical participation also requires existing files and supporting facilities of their departments. It would be also costly to gather all necessary technicians in the same office, since in all government departments, existing staff, budget and facilities, (desk computers, typing pool, reproduction facilities, etc.) can be used.

60. As rapid analysis and research on census data is a decentralized operation, the following suggestions are made:

- analysis and research units on census data should be created in all concerned departments and agencies: Department of Education, Department of Labour, Department of Housing and Town Planning, research units in universities, National Geographic Institute, etc.
- all specialized census data and analyses should be published under the joint sponsorship of the National Statistical Office and concerned departments. For example, population and household data by administrative divisions, subdivisions, and localities will be published in cooperation with the Ministry of Interior; census atlases in cooperation with the Geographic Institute; educational characteristics of the population in cooperation with the Department of Education, etc.

Analysis and publication would then be rapidly achieved, and in principle no serious staffing or budgetary problem would be encountered during this essential phase.

- the National Statistical Office (or the National Office) should limit itself to coordination and the publication of some basic documents.

Suggested Activities for the National Census Office

61. It is suggested that the National Census Office give priority to the following tasks:

- publication of a list of tables, with indications on the possible uses, precisions on area classification, number of pages, etc.
- publication of a short report on the methodological aspects of the census.

This report is mainly designed for users of census data, for the staff of research units mentioned above. Lengthy methodological reports are not read, except by some specialists, therefore they should not be given priority.

- coordination of analytical work undertaken by research units located in other government departments. Advisory services will be provided by the National Census Office, which will also apply standards and limit the objectives of the joint research programmes.
- publication of a report summarizing essential data collected by the census. Only basic tables should be published, and area classifications limited to major administrative divisions and important cities. This volume should also be short, and receive the widest circulation possible. It should be given free of charge to all government agencies and offices, at the national and local levels.