

# **Improving Cost-Effectiveness and Relevance of Agricultural Censuses in Africa: *Linking Population and Agricultural Censuses***

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## **Abstract**

Imperfect sampling frames and their negative impact on data quality have been a major technical issue in many African countries conducting Agricultural Censuses most of which are on a sample basis, due to the specific context of traditional subsistence farming systems in place. The paper is based on experiences of several African countries during recent years, in adopting some kind of coordination and linkage between Population and Agricultural Censuses in order to obtain, in a more cost effective manner, up-to-date and improved sampling frames for use in Agriculture Censuses and other subsequent surveys.

In addition to providing information for building improved sampling frames and better sample design, linking the two Censuses offers many advantages. The agriculture module of the Census of Population provides complete enumeration of agricultural households (and sometimes information on rural communities) which allows presentation of data for small geographical/administrative units, increasing considerably the value and relevance of the whole census operation. Also as the same identification of households is used for both censuses there is scope for in-depth analysis using cross-tabulations of agricultural data with the socio-economic and demographic data from the Census of Population.

The paper describes two country experiences and summarizes some of the lessons learned from these and other country experiences during the past 10 years.

## **1. Some features of agricultural censuses in Africa**

The Food and Agriculture Organization (FAO) of the United Nations, defines the Census of Agriculture as *“a large-scale, periodic, statistical operation for the collection of quantitative information on the structure of Agriculture. The word “census” implies a complete enumeration of all agricultural holdings. However, it can be conducted by a sample enumeration, provided the sample is large enough to generate sub-national data”* [FAO, (1995)].

In most African countries, the agricultural sector is characterized by the existence of a large number of small subsistence farmers producing food crops mainly for their own consumption. As area cultivated depends largely on available manpower, production is done on a number of small plots sometimes far away from the dwelling of the farmer’s family and not always located at the same place. Most farmers are still illiterate and do not keep records of area of plots cultivated, yield or production, and in some places, shifting cultivation is also used.

In this context, some key data related to the structure of agriculture, like crop area and other important current data like yield and production cannot be obtained by

direct interview of farmers<sup>1</sup>. Objective and physical measurements are required in order to generate accurate data. FAO has developed methods of measuring area, using compasses, tapes and programmable calculators. Crop cutting is used for estimation of yield and production. However, these methods are very time consuming and costly<sup>2</sup> and given the number of small farmers and plots involved, it is almost an impossible task to conduct a complete enumeration of all farms during an agricultural census. The situation may be even more difficult in countries with a large nomadic and semi-nomadic livestock sector.

This is why, for most African countries, the censuses of agriculture are being conducted on a sample basis in order to keep cost under an affordable limit. The effectiveness of the sample used to accurately represent the statistical universe of farms depends to a large extent on the quality of sampling frame used and have a considerable implication on the quality of census results.

Therefore, the availability of an appropriate sampling frame is a key issue in planning and conducting agricultural censuses in Africa. In fact some census results were never published because of the use of out dated and inappropriate sampling frame leading to obvious mis-representation of the reality.

## **2. Sample design and importance of proper sampling frame for agricultural censuses**

As stated above, because of resource limitations and constraints of traditional farming systems, sample enumeration is the most common feature of agricultural censuses in Africa. The sample design usually adopted is stratified two-stage sampling with Primary Sampling Units (PSU) being the Enumeration Areas (EA) or villages and the Secondary Sampling Units (SSU) the Agricultural Households which are often used to identify holdings<sup>3</sup>.

The sampling frame used for the selection of PSUs is usually derived from the last Population Census data and the selection is done at the first stage with probability proportional to some indication of size (pps). In many cases, the population census questionnaire includes questions to all qualified members of the household about *main activity* as well as *branch of activity*. When primary census files are available and accessible, this information is sometimes used to identify agricultural households when the household head or a household member has *agriculture* as the main activity. This criteria is used to determine the number of agricultural households (or the total population of agricultural households) in the EA which may be used as size indicator.

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<sup>1</sup> *In few countries like Cape Verde however, local measurement units are being used by farmers and provide the basis for good approximation of crop area.*

<sup>2</sup> *With the increased precision of Global Positioning Systems (GPS), there are very promising prospects of substantially reducing the workload of field staff for crop area measurement in the near future. Several tests are being conducted to evaluate comparative advantage of this new device as compared to the traditional method using tapes and compasses.*

<sup>3</sup> *Usually, it is assumed that there is a one-to-one correspondence between agricultural household and holding.*

However, the limits of this information and the risk of under-estimation are obvious. In many cases, the last population census is so remote that the access to basic files is almost impossible and in the absence of other information the total population of the EA or the total number of households is used for the size of the EA. In some other cases, PSUs (EAs or villages) are randomly selected with equal probability. Complete listing of agricultural households for selected PSUs is then done to build a frame for second stage selection and SSUs are selected, often a fix number with equal probability or fixed proportion, depending on the selection procedure used at first stage.

Depending on the time separating the last population census from the agricultural census, the frame used for selecting PSUs (EAs or villages) may be far from corresponding to actual situation regarding boundaries, composition and size and may be completely out-dated. Villages may have changed names, disappeared or new villages may have been created. This imperfection of sampling frames is a major source of over-all non-sampling error and has a serious impact on the quality of data generated by agricultural censuses in African countries. This is why several countries engaged in agricultural censuses in recent years have attempted to improve the situation in a cost-effective manner through better coordination of population census and agricultural census operations.

### **3. Coordination between population and agricultural censuses**

Population and agricultural censuses are large scale and very costly statistical exercises particularly for African countries, most of which have to rely on donor funding for these operations. Better coordinating these two major data collection exercises makes it possible to realize economies of scale as the infrastructure of population census may be used to collect relevant agricultural data needed for building up-dated sampling frame for the agricultural census.

The alternative of conducting an ad-hoc exercise for building a sampling frame for agricultural census will substantially increase the cost of the agricultural census operation. Experience shows that cost of agricultural censuses in the African context may vary from 3 millions dollars to 10 millions dollars (in particular if nomadic livestock is to be covered). An ad-hoc sample frame building exercise may add more than 20% to the cost of the census.

In the past, attempts of coordination between the two operations met strong resistance, as population census managers, thought that this linkage will get their operation out of focus and add a too heavy burden to the data collection exercise. In recent years however, with increasing scarcity of resources, several African countries, with advice of FAO, have adopted some type of coordination between the population census programme, in the broad sense, and the agricultural census.

Different countries have adopted different modalities of coordinating the two operations, depending on the phase of advancement of the preparatory work of the population census. The type of linkage between the two censuses vary across countries from conducting a comprehensive *pre-census* operation in conjunction with the field work for up-dating Enumeration Area maps (cartography) to including an

*agriculture module with a minimum number of questions* into the population census questionnaire. The benefits of this linkage are many.

First of all, even with a minimum agriculture module, up-dated sampling frame with additional information on statistical units can be constructed and valuable material for more effective sample design (stratification, optimization of sample size and selection procedures) will be available. As population census is conducted on a complete enumeration basis, some of the domains for which frames are difficult to obtain are covered. This is the case for example of urban and peri-urban agriculture, horticulture crops and some other crops which are location specific or rare.

Secondly, in the case of comprehensive pre-census, data on many variables related to the structure of agriculture may be obtained on a complete enumeration basis and some very valuable agriculture related community level data may be collected. As data become available for small geographical units, the relevance and value of the whole census increase considerably given the current context of policy focus on poverty and hunger alleviation which all are known to be location specific. The growing importance of decentralization policies also increases demand for data at lower administrative units not always provided by normal sample censuses. Pre-census may be considered in fact as complete enumeration phase (first phase) of a two-phase agriculture census; the second phase being conducted on a sample basis for collection of detailed structural data. Furthermore, since the same identification is used for both agriculture module and main population census questionnaire, there is scope for cross tabulation of agricultural related variables with socio-demographic variables which may add more value to data analysis.

Despite these potential benefits, the experiences conducted so far have been on an ad-hoc basis with a lot of advocacy and persuasion as collaboration between the two major Government institutions often responsible for the two censuses are not always as effective as it should be. Also, whatever technical solution is adopted (pre-census or agriculture module), there is an additional cost added to the population census exercise (questionnaires and manuals, training, enumerator's time in the field, supervision, data processing) and the coordination will work only if this is recognized and corresponding resources are made available.

#### **4. Country examples**

During the 2000 round of the World Census of Agriculture, several African countries have established some kind of linkage between population and agricultural census operations, ranging from a comprehensive pre-census in conjunction with cartographic operation in the field to including a small agricultural module into the main population census questionnaire. The following countries have conducted pre-censuses: Togo, Senegal, and Benin. Agriculture modules were introduced in population census questionnaires by Cote d'Ivoire, Rwanda and Uganda. The two approaches are briefly described below with two country examples: Togo for the pre-census and Rwanda for the agriculture module.

*Togo*

Given the socio-political situation in the country in early 1990s, which led to displacement of large segments of the population, it was considered that data available from the last population census could not be used as a basis for taking the agricultural census to be taken in 1996/97. Therefore, as the country was also planning to take a new population census it was decided to coordinate the preparation of the two major operations and to conduct a joint field exercise for updating the Enumeration Area maps. In conjunction with this exercise, a pre-census of agriculture was conducted on a complete enumeration basis, taking advantage of the infrastructure being mobilized in the field.

The main purpose of the pre-census of agriculture was to collect data on rural localities and agricultural households in order to build a proper sampling frame for the up-coming agricultural census. The pre-census had three specific objectives:

- Identification of agricultural households in newly delineated Enumeration Areas as a basis for building the sample frame for the agricultural census.
- Complete enumeration of agricultural households and population in all geographical units and agro-ecological zones.
- Collection of data on relevant socio-economic characteristics of agricultural households and localities.

Data from the pre-census was to provide a sampling frame not only for the agricultural census of 1996/97 but also for all subsequent sample surveys to be conducted in the agriculture and rural sector. Data from pre-census, combined with data from pilot census was to be used to improve the efficiency of the sample design for the census through a series of studies:

- Cost of data collection at PSU level and SSU level to contribute to determination of appropriate sample size given resources available and quality requirement.
- Optimum allocation of sample between first stage and second stage depending on variability within and between PSUs.
- Determination of the most appropriate variable to be used as measure of size of PSUs: number of agricultural households, agricultural population etc.

Two main types of questionnaires were used during the pre-census of agriculture.

#### **Village questionnaire:**

This questionnaire included socio-economic variables for all villages:

- Identification and general information (identification, village name, head...)
- Localization of the village
- Types of roads accessing to the village
- Infrastructure used for water and electricity
- Schools and training centers
- Economic infrastructures (market, agro-industries etc..)
- Languages spoken
- Main economic activities
- Fruit production

## Household questionnaire

The following variables were included:

- **Identification of Household**
- **Socio-economic characteristics** of the head of the household and household members
- Detailed information on the **activities of the household**

The data was used to build a sampling frame for the 1996/97 agricultural census (a sample of 9000 agricultural households were selected) and subsequent annual agricultural production surveys.

In addition, a specific report analyzing data from the pre-census was published which provided valuable information on the structure of agriculture of Togo well in advance of the release of the main census report. More importantly, village level data proved to fulfill an important demand for planning institutions within the Government as well as NGOs and other institutions operating at the field level.

### *Rwanda*

During the last Population Census (2002), the Government of Rwanda, decided to collect a limited number of information on the Agriculture and Rural Sector by adding to the main Census Questionnaire, an Agricultural Module. Given the socio-political turmoil that the country experienced in the mid-1990s an up-dated frame for agriculture was much needed. The objectives of adding this module were to:

- Provide a complete enumeration of all households of Rwanda engaged in agricultural activities (including livestock, agro-forestry and aquaculture), to serve as a basis for development of an efficient and up-to-date sampling frame.
- Provide a limited number of updated information on all agricultural households of the country, which allows for effective sample design (stratification, sample size calculation etc.) for all coming surveys in the sector.
- Analyze the agricultural data collected, which can be cross-tabulated with other census data for more in-depth analysis and presentation of a reference situation in the agricultural sector. The use of the same household identification number in the Population Census Questionnaires and in the Agricultural Module, make it possible to do automatic linkage between the files and to extract tables crossing agricultural data with other socio-economic data at all levels.

### **Agricultural Module**

- **Identification of Household:** province, district, sector, "cellule" (village), enumeration area, household number and name of head.
- **Identification of Agricultural Households** (Households operating an agricultural holding).

- **Type of agricultural holding operated by the Household** (agriculture, livestock, fishery and all combinations)
- **Crop grown by the agricultural household** (8 main crops identified with all combinations)
- **Livestock raised and numbers** (5 main livestock identified)
- **Ownership of land**

The Population Census used a Main Questionnaire for Ordinary Households and a Form for collecting information on existing infrastructure in all villages. The census questionnaire included detailed questions related to:

- **Identification of Household**
- **Housing (and other living conditions of the Household)**
- **Individual Characteristics of Household Members**
- **Deaths during the last 12 months**

Forms for collecting detailed and geo-referenced information (using GPS), on existing infrastructure in all villages of Rwanda were also used to collect the following information:

- **Localization of the village**
- **Socio-economic and cultural infrastructure in the village** (up to 10 infrastructure may be listed with GPS coordinates)

The data collected is being used mainly to build an up-dated and effective sampling frame for the agricultural census envisaged and all sample surveys to be conducted on agriculture and rural sector. The sampling frame is made of the list of all Enumeration Areas (and villages) with the following information:

- Total number of households
- Number of agricultural households (crop, livestock, aquaculture, agro-forestry)
- Number of households engaged in crop production, in livestock, aquaculture, agro-forestry and other agricultural activities
- Number of households engaged in the production of each major crop and type of livestock.

The data collected is being also used to provide detailed tables for analysis of the agriculture sector at all major geographical levels. The following types of tables are available:

- Number of agricultural households for all Provinces and districts
- Number of agricultural households for all agro-ecological zones
- Distribution of agricultural households by province and districts and by type of activities (crop production, livestock, aquaculture, agro-forestry)
- Distribution of agricultural households by province and districts (and by agro-ecological zones) by type of crops and by type of type of livestock
- Livestock numbers by Province, district and agro-ecological zones.

It is envisaged to cross-tabulate data from the agricultural module with socio-demographic data from the main Population Census Questionnaire for in-depth analysis.

## 5. Lessons learned

### *Coordination of the two census programmes at UN level*

Despite general recommendations on coordination between Population and Agricultural Censuses in the Programmes for the World Census of Agriculture prepared by FAO for each decennial programme, the experiences conducted so far come mainly from initiatives taken at country level. Since the UNFPA and FAO are the main organizations technically sponsoring the Population and Agricultural Censuses, much stronger and coordinated recommendations as well as adequate guidelines by these organizations will provide reference to countries and facilitate the linkage of the censuses. FAO is taking necessary steps in this direction within the framework of the up-coming programme for the World Census of Agriculture 2010.

### *Modalities of linkage*

The modalities of linking the two censuses will continue to vary from one country to another as many factors are to be considered. It should however be recognized that cost implications are very different from a comprehensive pre-census to a limited module on agriculture as part of the census questionnaire. Whatever the case, additional funds will be required to cover for the extra costs for printed material (questionnaires and manuals), training, enumerators and supervisors time, and data processing. In view of the significant benefits to be gained with this linkage as compared to cost, for the agricultural census and subsequent surveys, it is worth mobilizing the extra resources needed.

### *Type of questions and variables for an agriculture module*

The experiences conducted show that, the type of questions and variables most appropriate are simple often qualitative questions (type of activity, type of crop grown, etc...) not requiring precise measurement. Given the short timeframe in which population census questionnaires are to be filled, and the type of enumerators used, attempts to get precise numbers (like livestock numbers) have failed to provide accurate results. Even data on population numbers was not precise enough in the case of the pre-census of Togo as questions were asked to household heads and detailed questions on household members were not asked.

### *Timing of the population census field operations and implication for agricultural module*

The most appropriate period for collecting adequate data on agriculture is the cropping season. Therefore for pre-censuses and agricultural modules to better capture relevant data, it is advisable that field operations be conducted during agricultural season. Fortunately, in many African countries, population censuses are conducted during the summer vacation periods in order to take advantage of the availability of large numbers of students and teachers who can be used as field personnel and this period coincides with cropping seasons in many places.

### *Data processing and analysis*

The timely processing of the agriculture module depends to a large extent on advance planning and provision of adequate resources before the data is collected. If the module is to be processed by the Bureau of the Population Census, the module will most probably be the last questionnaire to be processed as higher priority will be given to population census main questionnaire. On the other hand, the cost of processing will be much reduced as the data processing infrastructure of the population census (computers and data entry clerks) will be used for the agriculture module. This was the case in Rwanda where a delay of several months occurred as the Bureau has to complete data entry and editing of the main population census questionnaire before starting work on the agricultural module. On the contrary, the pre-census of Togo was rapidly processed as resources were made available within the Ministry of Agriculture to quickly process the data to be used for the agricultural census and there was no competing data entry activity.

Data analysis has to be also planned in advance and resources provided for, if a report is to be prepared in time on the basis of the data from agricultural module. During the experiences conducted so far cross-tabulation of agriculture data with population data from population censuses has not been done but in Rwanda this option is still being envisaged.

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