Master Sampling Frames for Agricultural and Rural Statistics Experience of Lesotho

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ABSTRACT

Agricultural Production Survey (APS) is an annual survey, which is undertaken by Lesotho Bureau of Statistics. The survey runs throughout the agricultural year; from the 1st of August of the current year to 31st July of the following year. In every ten years, the Bureau carries out the agricultural census to generate data on variables that do not change much overtime and also serve as an indispensable base for assessing reliability of current agricultural statistics. Both APS and agricultural census concentrate on the production of both livestock and crops in the rural parts of the country.

This paper presents Lesotho Agricultural Production Survey design and sample selection methodology. For both annual agricultural survey and/or agricultural census, Stratified multi-stage cluster sampling design is adopted for the selection of the sample. Two or three enumeration areas are combined to form a Primary Sampling Unit (PSU). A Probability Proportional to Size (PPS) is used for the selection of PSU’s where households are taken as measure of size. Individual farming households constitute Secondary Sampling Units (SSU’s) and Systematic Sampling Technique is adopted for selection of SSU’s. For the estimation of crop yield, fields for each of the main crops per PSU are selected following systematic sampling technique and these fields constitute third stage sample units. Another sample of fields for crop forecasting is done from the sample of selected field for crop production.

Keywords

Agricultural Production Survey (APS), Agricultural Census (AC), Stratified multi-stage Cluster sampling design, Primary Sampling Units (PSUs), Secondary Sampling Units (SSUs), Probability Proportional to Size (PPS), Systematic sampling
1. Introduction

Lesotho is situated in the southern part of Africa and is land locked by the Republic of South Africa. According to the 2006 Population and Housing Census, total population stood at 1,872,721, of which about 51.4 percent was females. The country’s total area is 3,035,500 hectares, of which 325,000 hectares is arable.

The mandate of Lesotho Bureau of Statistics (BOS) is to collect, compile, process, analyse and disseminate statistical data. BOS has been collecting agricultural data through Annual Agricultural Production Surveys (APS) and Agricultural Sample Censuses every 10 years from as far back as 1973. The difference between the annual surveys and Agricultural Censuses is that for the census, the sample size is increased to give a wider coverage and hence increase precision of the estimates. For the most recent Agricultural Census, the 2009/10, the sample was increased by 10 percent from the 2008/09 annual APS.

The major types of agricultural data collected by BOS are crops and livestock for both rural and urban setting. Rural crop statistics covers area planted, production by crop, yield per hectare, land utilization per season and cereal availability and utilization per year. Livestock Statistics gives livestock inventory and stock changes within a survey period.

The Urban Statistics Report covers vegetables planted and livestock reared in urban households. The type of agriculture practiced in Lesotho is mainly subsistence with minimal commercial farming. Farming households are identified after stratification of households into farming and non-farming following listing operation in the selected Primary Sampling Units (PSU’s) of the master sample.

2. Development of the Master Sampling Frame for agriculture and the household surveys

Kiregyera defines sampling frame as list of distinct and distinguishable units of a given population which is used for selecting units from the population into a random sample. Like in other developing countries, Master Sampling Frame in Lesotho is designed as a basis for selection of different samples for various surveys or different rounds of a single survey. The sample for annual agricultural production survey has been selected from the Lesotho Master Sampling Frame that is designed for all surveys that are likely to be conducted within the same period.

During the developing Master Sampling Frame, quality of data should be the priority from the surveys selected for the frame. The completeness of the sampling frame pays a very important role to avoid under-coverage (Statistics Canada, 2010). The most important source of quality data is population census. The current master sampling frame was constructed from the 2006 Population and Housing Census.

According to Pettersson, it is desirable for the basic frame units to be small areas that will allow for a grouping of the units into larger sampling units to meet survey’s cost considerations. In Lesotho, the enumeration areas (EAs) are the best frame units as they are well demarcated and
documented. The average measure of size is attached to each EA. Samples can be drawn from master sampling frame by sampling EAs or by grouping EAs to form larger PSUs. List of Households form second stage sampling units. The Agricultural Census uses frame of institutions. BOS had developed the first frame of community when conducting of 2009/10 Agricultural Census. For each unit of the master frame, the information is distributed by rural/urban, district, zones, Community Council and Constituencies.

2.1 Area Frame

The 2006 Housing and Population census enumeration areas are regarded as the basic unit of BOS Master Frame. The Enumeration areas are well defined and cover the totality of Lesotho territory, there is no duplication of units nor is overlapping, hence complete coverage insured. All the EAs and PSUs are geo referenced. In the first stage, probability proportional to size was used to select the enumeration areas to be included in the sample.

For administrative purposes, Lesotho is divided into ten districts. Within the districts there are four agro-ecological zones. These zones experience different climatic conditions; they are therefore regarded as strata. The lowland zone is most densely populated and an intensively cultivated zone with relatively high chances of rainfall. The foothill zone, as compared to lowland is less populated with less rainfall. The mountain zone is the largest zone of the country that is characterized by very cold winter. Senqu River Valley is the smallest zone which runs from the east to the west across some districts. Stratification is also done by rural and urban dichotomy. The districts are regarded as domains of study for all BOS surveys. Table1 illustrates the strata used for BOS Master Frame across districts.

<table>
<thead>
<tr>
<th>District</th>
<th>Rural Lowlands</th>
<th>Rural Foothills</th>
<th>Rural Mountain</th>
<th>Rural Senqu River Valley</th>
<th>Urban Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botha-Bothe</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
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</tr>
</tbody>
</table>

*Source: Household Budget Survey, Volume1, 2006*
2.2 The List Frame

Households form second stage sampling units. The list of households comprises the total number of households within a PSU. Apart from giving sample selection, number of households is used to determine the allocation of sample PSU to strata, to form sampling units of a desirable size and to form strata of units classified by size. Within the rural area, an EA is delineated to have about 60 to 80 households while in the urban, the range is between 100 and 150 households on average.

2.3 The Institution Frame

The institution frame is composed of schools, prisons and projects. All the institutions engaged in agricultural activities within the selected PSU form secondary sampling units. This frame is used during the Agricultural Census not with annual APS data collection.

2.4 The Community Frame

Both Community Level and agricultural Census data collection were done concurrently as part of World Census of Agriculture 2010. However, the community level data covered agricultural, social and economic related data not collected from holdings.

The community questionnaire was designed to give community profile from the village level, community council up to the district level. Data collected from the community profile was of interest in an agricultural census especially for decentralized planning, identification of poor villages, planning of targeted area development programmes and targeting communities for relief operations in case of natural disasters. The respondents for community information were either village chiefs or councilors or both parties.

The 2009/10 community level data provides list of agricultural, social and economic establishments such as agricultural input dealers, wool sheds, sheep studs, facilities such as education, health and agricultural and village programmes like water provision and infrastructure. This information is useful for stratification of villages with or without facilities.
3. The BOS Master Sampling Frame

The development of a Master Sampling Frame and a master sample for the surveys is often an important part of an Integrated System of Household Surveys (ISHS). Master Sample frame becomes basis for sample selection required for data collection of all surveys conducted by the Bureau. This enables correlation of information from those surveys at the area level. It enables certain linkages, such as sharing of survey personnel, using same definitions and concepts, sharing of facilities like transport, etc, for different surveys. These result in effective and efficient coordination between surveys. It is also effective in that once permission from regional and local authorities has been secured when the first survey is conducted, time is saved to conduct subsequent surveys as there is no need to ask for permission again. It is easy to locate households by interviewer residing within the area.

There is need to periodically up-date the master sample to properly account for post-censal growth on a large scale such as that which occurs in high-rise residential construction in urban areas. The list frame is also updated to reflect migration, births and deaths.

3.1 Using BOS Master Sampling Frame

Stratified Multi-Stage Cluster Sampling design is adopted for the selection of the survey sample. In the rural areas, in the first stage, PSUs are constructed with combination of 2 to 3 adjacent enumeration areas from population and housing census. The PSUs are selected with Probability Proportional to Size (PPS). In the urban areas, the enumeration areas are used as
PSUs. All households in the selected PSU’s are listed, for APS the households are classified into the following four categories:

Rural Agricultural Production Survey:

- Households operating at least one field
- Households raising at least one cow, sheep, goat, improved pig and or 50 improved chicken
- Households operating both fields and livestock
- Households without fields and livestock

Urban Agricultural Production Survey:

- Households operating kitchen garden and /or vegetable field
- Households raising at least one cow, sheep, goat, improved pig, and or 50 improved chicken
- Households operating both fields and livestock.
- Households without fields and livestock.

These stratifications for both rural and urban agricultural surveys justify the need to update list frame every two to three years since the ownership or operation of livestock and or fields do not last for a long time. None farming households are excluded from the agricultural frame. A sample of farming households is then selected by systematic sampling from each selected PSU.

Finally, for estimation of crop yield in each sample PSU, a maximum of fifteen fields under each principal crop are selected with equal probability for each crop.

The selected PSUs (group of EAs or single EAs) for APS, UAPS and or AC are also selected for Continuous Multi-purpose Household Survey (CMS). The two parallel surveys are maintained as their data collection is done within the same areas. Since the agricultural sector is composed largely of small farming households, partial integration of rural household and agricultural survey is observed. The demographic variables are the same for both surveys. This eases the comparison of findings hence assurance of quality and reliable statistics produced by BOS.

Most developing countries use list frame approach for data collection of agricultural surveys because of unavailability of good land records (United Nations, 1986). Use of list frames is time consuming, as mentioned earlier, there is a need to update list of household prior to every data collection of APS. It has been established that list frame as it uses the indirect measure of field size, provide information on different area planted as compared to area frame. To some crops, list approach gives large area planted while to others area planted is smaller than area approach (Central Statistics Agency, 2011).
3.2 Sample Rotation

BOS adopts the Sample Rotation Scheme in every two years, the different enumeration areas are selected while with households the rotation is done annually. This scheme is used to reduce the respondent fatigue caused by repeated interviewing, avoid the expense of selecting a completely new area sample each year, and provide reliable measures of change in the production of agricultural commodities from year to year.

4. Documentation of Master Sampling Frame

Master Sampling Frame is well kept and easily accessible for selection of Master Sample and maintenance thereof. BOS has computerized data base containing all the enumeration areas identified with codes. Once downloaded, it becomes easy to execute sorting and filtering during sampling.

5. Conclusion

The purpose of the global strategy to improve agricultural statistics is to provide the vision for national and international statistical systems to produce the basic data and information to guide the decision making required for the 21st century. The draft global strategic plan puts emphasis on the integration of agriculture into the National Statistical System which is built on the concept that all census and survey data collections for agriculture be based on sample units selected from a Master Sample Frame for agriculture as a single source (World Bank, 2010). As indicated earlier, the BOS has developed its Master Sample Frame basically from its Population censuses. A Master Sample Frame has been used for selection of primary sampling units (PSUs) for agriculture and household surveys.

The second stage sampling units for both CMS and APS are households. BOS is cautious so as to avoid risks of biases resulting from conditioning effects and increased non response caused by the cumulative response fatigue hence PSUs are selected every two years.

With efforts being made to produce accurate, timely and reliable data for evidence-based planning, decision making, research, policy, program formulation and monitoring and evaluation to satisfy the needs of users and producers, the division of Agriculture and Food Security produce Crop Forecasts Report by end of May. This information is needed to inform Government planners and other private sectors with forecasted crops production so as to make effective decision concerning availability of food in the country and to make necessary preparations if there is a shortage of food. The actual crop production estimates are reported by October. However, for more timely and accurate data, advanced methodological changes and technology such as portable computers for data collection need to be employed. BOS together with Ministry of Agriculture and Food Security have to work towards construction of area frame approach where the observation units are territorial sub divisions and weigh the advantages of using multiple frame i.e. list frame and area frame to improve area under crop.
Annex 1: PSU no.04-38-2-06
Annex 2: APS and CMS Listing Form

### Agricultural Production Survey Listing Form

#### Identification Information

<table>
<thead>
<tr>
<th>District</th>
<th>Population</th>
</tr>
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<tbody>
<tr>
<td>Constituency</td>
<td>Male</td>
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<tr>
<td>Community</td>
<td>Female</td>
</tr>
<tr>
<td>Zone</td>
<td>Total</td>
</tr>
<tr>
<td>EA Code</td>
<td>Households</td>
</tr>
</tbody>
</table>

**NB:** R – Residential, N – Non-Residential, B – Both Residential and Business

<table>
<thead>
<tr>
<th>ST no.</th>
<th>HH no.</th>
<th>Type of Use: R, N and B</th>
<th>Name of Household Head</th>
<th>Sex</th>
<th>No. of Persons</th>
<th>Do you own fields? 1: Yes 2: No</th>
<th>Do you operate fields? 1: Yes 2: No</th>
<th>No. of cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>(B)</td>
<td>(1)</td>
<td></td>
<td>(2)</td>
<td>(3)</td>
<td>(4a)</td>
<td>(4b)</td>
<td>(5)</td>
</tr>
<tr>
<td>(6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(7)</td>
</tr>
</tbody>
</table>

**NB:** R – Residential, N – Non-Residential, B – Both Residential and Business

<table>
<thead>
<tr>
<th>ST no.</th>
<th>HH no.</th>
<th>No. of Sheep</th>
<th>No. of Goats</th>
<th>No. of improved pigs</th>
<th>No. of improved Chicken</th>
<th>No. of other chicken</th>
<th>No. of doves</th>
<th>No. of Turkeys</th>
<th>Other poultry not stated (specify)</th>
<th>Do you own forestry? 1: Yes 2: No</th>
<th>OFFICE USE ONLY</th>
</tr>
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<tbody>
<tr>
<td>(A)</td>
<td>(B)</td>
<td>(8)</td>
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</table>
REFERENCES


Pettersson, H. Household Sample Surveys in Developing and Transition Countries

Statistics Canada, 2010. Survey Methods and Practices, Ottawa, Canada


Report Number 56719-GLB. Washington, DC: Worldbank, September 2010