Agricultural Statistics Best Practice Methodology Handbook

Implementation in APEC Member Economies

APEC Agricultural and Technical Cooperation Working Group

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Abbreviations

BRR	Balanced repeated replication
CI	Confidence interval
CV	Coefficient of variation
Deff	Design effect
EA	Enumeration area
EPSEM	Equal Probability Selection Methods
FAO	Food and Agriculture Organization of the United Nations
FSUs	First stage units
GAP	Good agricultural practices
GM	Genetically modified
ILO	International Labour Organization
IPM	Integrated pest management
IPPS	Inclusion probability proportional to size
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
ISIC	International Standard Industrial Classification of all Economic Activities
MDG	Millennium Development Goal
MoS	Measure of size
MPPS	Multivariate probability proportional to size
NSE	Nonsampling errors
PPS WOR	Varying probability sampling without replacement
PPS WR	Probability proportional to size sampling with replacement
PPS	Probability proportional to size
PSU	Primary sampling unit
SA	Subadministrative
SRS	Simple random sampling
SRS	Systematic sampling
SSU	Secondary sampling unit
UN	United Nations
WCA	World Census of Agriculture
WOR	Without replacement
WR	With replacement

Acknowledgments

This handbook is based on two publications by the Food and Agriculture Organization (FAO) of the United Nations and reproduced with permission:

- *A system of integrated agricultural censuses and surveys, Volume 1, World Programme for the Census of Agriculture 2010*. FAO Statistical Development Series 11, Rome (2005).
- *Reference Material on Sampling Methods*. Technical note by A.K. Srivastava for the Regional Workshop on the Use of Sampling in Agricultural Surveys, Montevideo, Uruguay, June 2011 (2011).

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Introduction

Reliable and timely agricultural data provide producers and governments the information they need to make well-informed decisions in business and policy. Such data also improve food security by informing the development of strategies to combat poverty and measure the impact of interventions. Statistics compiled according to agreed on good practices, including practices for data collection, processing and dissemination, are crucial for economic and social development, providing an objective and replicable picture of the state of an economy, enabling comparisons, and setting baselines for measuring progress.

APEC's Agricultural Technical Cooperation Working Group has identified the lack of reliable agricultural data, particularly from APEC developing economies, as a problem to be solved. In response, USAID's APEC Technical Assistance and Training Facility (TATF) program, in coordination with the U.S. Departments of State and Agriculture, organized the *APEC Workshop to Assess and Improve Agricultural Data Collection and Dissemination by APEC Member Economies* in Manila, Philippines, October 27-28, 2011. The workshop focused on the need to institute best practices in agricultural data collection and use good data collection tools; on the challenges facing economies in collecting data; and on how reliable and timely agricultural data are essential to trade, investment, and food security policymaking. The workshop concluded that APEC member economies need to do more to improve the collection and dissemination of agricultural data, including strengthening political commitment to improving statistical systems and integrating them into national statistical organizations.

To begin addressing this need, APEC TATF conducted a baseline study of APEC economies' practices in agricultural statistical data collection in the second half of 2012. The study was based on international best practices laid out by the UN's Food and Agriculture Organization (FAO) in its series on the collection of agricultural statistics. *Best Practices in Agricultural Statistics in APEC Member Economies* compared each economy's practices to FAO guidance by analyzing websites relating to agricultural statistics and data and determining the degree to which each economy conformed with FAO guidance as described in the *Global Strategy to Improve Agriculture and Rural Statistics*[1] and the *Asia-Pacific Regional Action Plan to Improve Agricultural and Rural Statistics 2013-2017*.[2] This analysis indicated where data collection systems and processes could be adjusted to improve quality, openness, and transparency.

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[1] Report Number 56719-GLB, World Bank, Washington, DC, 2011.

[2] Improving Statistics for Food Security, Sustainable Agriculture and Rural Development, FAO Report Number APCAS/12/10, Rome, 2012.

This handbook provides guidelines for implementing best practices in agricultural surveys as presented in the FAO's Global Strategy and for addressing many of the shortfalls revealed by *Best Practices* study. The handbook draws heavily on FAO literature and the FAO's database of agricultural statistics, with emphasis on ways to achieve best practices in agricultural statistics and improve the coverage, consistency and quality of published data on food and agriculture in all APEC economies.

Part I draws heavily on the FAO's *A system of integrated agricultural censuses and surveys.*[3] Material in the appendix draws on Chapter 11 of the same publication to define best practice core items discussed in the baseline study. Part II draws heavily on the FAO's *Regional Workshop on the Use of Sampling in Agricultural Surveys - Reference Material on Sampling Methods.*[4.] This reference material may be used by the statistical offices in each APEC economy in conjunction with their own plans to improve their agricultural survey systems.

[3] Volume 1 of the *World Programme for the Census of Agriculture*, FAO Statistical Development Series 11, Rome, 2010. Available at http://www.fao.org/docrep/009/a0135e/a0135e00.HTM

[4] Published in Montevideo, Uruguay, June 2011; technical note prepared by A.K. Srivastava, FAO Consultant, Rome, 2011. Available at http://www.fao.org/fileadmin/templates/ess/ess_test_folder/Workshops_Events/Workshop_Montevideo/Sampling_Methods_Montevideo_2011_Final_01.pdf

Part I. Design of Agricultural Census and Survey Implementation

What to Consider When Designing a Survey

1. Importance of the Census of Agriculture

This chapter examines why it is important for an economy to undertake a census of agriculture. The uses of agricultural census data in a variety of economic and social fields are described. Special emphasis is given to the use of agricultural census data to help in monitoring progress towards the Millennium Development Goals, and in analyzing poverty, food security and gender issues. Using agricultural census data for planning and policy-making in other areas is examined and examples are provided. The use of agricultural census data for improving current agricultural statistics is also highlighted.

1.1 INTRODUCTION

Statistical needs for agricultural planning and policy-making are very broad. The primary needs are for current agricultural statistics produced on a regular basis, such as crop and livestock production, and most economies have established an ongoing system for the collection of these data. Current agricultural statistics are usually collected through administrative reporting systems and/or through sample surveys. Current agricultural statistics are needed to monitor current agricultural and food supply conditions and to provide information to help governments and others in short-term decision-making.

One feature of a census of agriculture is that it involves the collection of data at the individual holding level. Many economies compile current agricultural statistics based on reports from local officials because they do not have the resources to collect data directly from farmers in sample surveys. This reporting method of data collection is cheap and easy, but data quality often suffers because of poor reporting and the lack of sound statistical concepts and procedures. In these circumstances, a census of agriculture can be invaluable in providing a statistically sound source of agricultural statistics.

Another advantage of a census of agriculture over administrative reporting is the wider range of data that can be produced. In an administrative reporting system, aggregated data are usually forwarded up through the various administrative levels. This means that, in a crop reporting system, for example, the only data available would be province or district totals for crop area. In an agricultural census, data are collected and processed at the holding level. As well as getting data on the total area of crops planted, for example, an agricultural census would show the number of holdings with each crop, the distribution of crop area, and the average crop area planted, as well as cross-tabulations with other items, such as area planted classified by household size. An agricultural census can also provide data for any specific geographic area, even non-standard groupings. These aspects greatly enhance the usefulness of agricultural census data.

1.2 MONITORING THE MILLENNIUM DEVELOPMENT GOALS

1.2.1 What are the Millennium Development Goals?

In the United Nations Millennium Declaration of 2000, governments around the world committed themselves to sustainable economic growth, focusing on the poor and with human rights at the center. The declaration called for combating poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women.

To help track progress in meeting the commitments of the Declaration, a set of time-bound and measurable Millennium Development Goals (MDGs) was developed. The MDGs comprise a framework of 8 goals, 18 targets and 48 indicators to be used to assess progress between 1990 and 2015, when targets are expected to be met. For more information on the MDG indicators, refer to *Indicators for Monitoring the Millennium Development Goals – Definitions, Rationale, Concepts and Sources* (UN, 2003).

1.2.2 MDG Indicators

Economy-level monitoring of the progress towards the MDGs has become an important element in formulating economic development strategies, and economies have begun to focus on the need for MDG-related indicators as a key component of the national statistical program. A variety of data sources are being sought for this purpose. A census of agriculture is one of the largest statistical collections undertaken by an economy, and its use as a source of data for monitoring the MDGs should be taken into consideration in the census planning and design.

The new modular approach used for the current round of agricultural censuses, based on the census core and supplementary modules together with the program of agricultural surveys, enhances the usefulness of the agricultural census/survey program as a source of data for MDG monitoring. Economies could look to carrying out regular agricultural surveys, based on the agricultural census frame, to provide additional MDG-related data to complement the data collected in the agricultural census.

Coordinating the agricultural census with the population census may also provide opportunities for a wider range of data for monitoring the MDGs. Population censuses provide a lot of data specific to the MDG indicators, such as child mortality, school enrolment, the gender indicators, and perhaps even income/poverty and literacy. If the agricultural census data could be linked to the population census data, it would open up the possibility of providing these MDG indicators for specific groups of farm households.

One problem in using the agricultural census for monitoring the MDGs is that it normally covers only agricultural holdings. Thus, indicators provided by the agricultural census relate specifically to agricultural holdings, not to all households or even all rural households. WCA 2010 provides the option to widen the scope of the agricultural census to cover all rural households, which might provide more useful MDG measures.

Agricultural censuses are normally undertaken every ten years and this provides a good basis for monitoring the MDGs over time. An agricultural census could provide a range of data of interest to the MDGs:

- Goal 1: Eradicate extreme poverty and hunger. This goal calls for halving the proportion of people who suffer from hunger. Two MDG indicators are used: the prevalence of underweight children under five years of age (Indicator 4); and the proportion of population below the minimum level of dietary energy consumption (Indicator 5).
- Goal 2: Achieve universal primary education. Some data relating to enrolment ratios in primary education (MDG Indicator 6) are often available from the agricultural census.
- Goal 3: Promote gender equality and empower women. MDG Indicators 9–11 relate to gender disparity in education and non-agricultural employment. The agricultural census does not directly provide these measures, but it provides a range of data related to the role of women in agricultural production activities and the participation of rural women in non-farm economic activities.
- Goal 7: Ensure environmental sustainability. This calls for "integrating the principles of sustainable development into [economy] policies and programs and reversing the loss of environmental resources". An agricultural census may also be useful for two specific MDG indicators:
  - — Indicator 25 refers to the proportion of land area covered by forest. The agricultural census provides data on the forest land operated by agricultural holdings.
  - — Indicator 32 refers to land tenure in urban areas. The agricultural census provides land tenure data for agricultural holdings and allows better understanding the effect of security of land tenure on agricultural practices and household food security.
- Goal 8: Develop a global partnership for development. MDG Indicator 45 refers to the unemployment rate for persons aged 15 to 24. These data are available from the agricultural census for household members of agricultural holdings. If the scope of the agricultural census was widened to cover all rural households, more meaningful MDG-related data relating to the rural sector could be provided.

A community-level data collected as part of the agricultural census could also provide data to help in monitoring the MDGs, especially for Goal 7: Ensure environmental sustainability could provide data relating to several MDG indicators for this goal:

- Indicator 25: proportion of land area covered by forest.
- Indicator 30: proportion of population with access to safe drinking water.
- Indicator 31: proportion of population with access to improved sanitation.

WCA 2010 has been formulated with the MDG indicators in mind and particular attention has been given to ensuring that concepts and definitions for the agricultural census are consistent with international standards and with the requirements for monitoring the MDGs.

1.3 POVERTY MONITORING AND ANALYSIS

Achieving sustainable economic growth with the focus on combating poverty has become the key development goal for governments around the world, as reflected in the MDGs and, in particular, Goal 1. Most of the poor live in rural areas, often in isolated conditions, where they face problems of poor natural resources, underdeveloped infrastructure, lack of access to

markets, fluctuating commodity prices, lack of employment opportunities, and vulnerability to natural disasters. The agricultural census helps to better understand the causes of poverty and provide baseline data for monitoring poverty alleviation programs.

Many poor farmers seek to be self-sufficient in food, carrying out traditional forms of low productivity production. The agricultural census crop data can underline the potential for raising farm incomes through crop diversification and the adoption of high value crops. Farmers are often unable to raise their living standards because they. The agricultural census data can help to highlight problems where farmers cannot access services that might enhance their productivity, such as credit, extension and veterinary services. Data on the degree of farm mechanization and the types of inputs used can help to identify other factors constraining farmers from increasing their agricultural productivity.

The community-level data collection is introduced for the first time in the 2010 program and can provide a useful source of data on infrastructure issues affecting farmers' incomes, especially relating to the access farmers have to agricultural produce markets and whether farmers and their families have alternative employment opportunities.

Economies that have a system in place to identify which communities are poor can use this as the basis for an economic status measure in the community survey and can be valuable in analyzing the agricultural characteristics of holdings in relation to whether they live in a "rich" or "poor" community.

Usually, income and poverty data at the household level are not directly collected in an agricultural census, but under the modular approach for WCA 2010 an economy can include such data, if required. Another approach is to develop a proxy for income/poverty measures from other data collected, such as farm size, land tenure, and ownership of farm machinery.

1.4 FOOD SECURITY MONITORING AND ANALYSIS

The goal set by the World Food Summit in 1996 to halve the number of undernourished in the world between 1996 and 2015 has become a key focus of governments around the world and the importance of combating hunger while achieving economic growth is one of the cornerstones of the MDGs, as reflected in Goal 1.

Data from the agricultural census helps in understanding the structure of the food production industry and the constraints faced by farmers in increasing agricultural production. Cropping patterns along with information on the use of irrigation, farm machinery and improved varieties of seed can help develop programs for increasing food production.

The agricultural census also addresses food access issues with the collection of community-level data useful in this area. Also issues related to stability of food supplies, such as weather conditions and exposure to natural disasters, can also be studied from the community component of the agricultural census.

The agricultural census also provides broad economic, social and environmental indicators to show the background against which the food economy operates, help in studies of environmental issues that may affect agricultural output, and the use of fertilizers and pesticides. Household data from the agricultural census can also highlight social issues affecting food security, such as changes in demographic patterns and household structures.

The inclusion of a census supplementary module on food security is an important initiative in WCA 2010 that allows direct measures of household food security. Anthropometric data for children would enable the effects of food insecurity on nutritional status to be directly measured. This would help answer questions such as whether subsistence farmers, or farmers not owning their own land, are more prone to be food insecure.

1.5 MEASURING THE ROLE OF WOMEN IN AGRICULTURE

Goal 3 of the MDGs acknowledges the promotion of gender equality and empowerment of women as key elements in advancing social and economic progress. The agricultural census has an important role to play in providing gender data related to agriculture to help monitor progress towards achieving gender equality goals. Efforts have been made to bring a greater gender perspective to WCA 2010 to help in addressing these issues.

The contribution of women to agricultural development and the problems in accurately measuring women's involvement in agricultural production activities makes the agricultural census important for studying the social and cultural patterns of agricultural and rural development as they relate to women, the distribution of agricultural work within households, and the different household member's contribution toward the agricultural holdings. For more on gender issues in agricultural censuses, refer to *Agricultural Censuses and Gender Considerations: Concepts and Methodology* (FAO, 1999).

The identification of the agricultural head-of-household provides the basis for comparing the characteristics of holdings operated by men and women. In WCA 2010, the concept of agricultural holder has been modified to recognize that the agricultural holder could be a group of persons – for example, a husband and wife. This should better reflect the realities of farm management practices, especially related to the role of women. The agricultural holder concept is often difficult to apply because of a; in WCA 2010, economies are strongly urged to address gender bias in the reporting of data in the design of questionnaires, development of field procedures, training of field staff, and management of the data collection operation.

Data on the economic activity of each household member can be used to study the division of labor within households and the responsibilities of women for work on and off the holding. The problems in collecting accurate employment-related data, especially for women in rural areas, have been acknowledged in WCA 2010, and improved guidelines for the collection of these data have been provided. For example, if women tend to be responsible for managing livestock, the census would provide information on the number of women performing this role, their demographic characteristics, main occupation, time spent in work on and off the holding, and the type of livestock they manage.

1.6 AGRICULTURAL PLANNING AND POLICYMAKING

As previously mentioned, an agricultural census provides the opportunity to analyze the characteristics of agricultural holdings and their agricultural production activities, as an aid to helping the government and others in effective planning and policy-making.

The use of the agricultural census for policy-making and planning in relation to poverty and gender issues has already been noted in previous sections. Other examples of planning and policy issues that can be analyzed using the agricultural census are:

- Study of a specific crop. Census tables specific to agricultural holdings with the particular crop – for example, coffee – can be used to measure the number and location of coffee growers, the distribution of coffee growers by plantation area, cropping systems used by coffee growers, labor requirements for coffee growing, etc.
- Study of a specific livestock production system. Census tables specific to agricultural holdings with the particular livestock type – for example, sheep – can be used to measure the number and location of sheep producers, the distribution of sheep producers by flock size, the integration of sheep raising with cropping activities, etc.
- Structure of agriculture in a particular area. Census tables relating to the particular geographic area, such as a district, can highlight the main crops grown and livestock raised in the district, the agricultural practices used in the district in comparison with other districts, employment characteristics in the district, etc.
- Inter-relationship between crop and livestock production. Census tables can be prepared showing the number of holdings with specific combinations of crop and livestock types.
- Sources of farm labor. Census tables can be prepared to show the types of farm labor inputs for specific farming systems and the role of household and outside labor.
- Farm typology studies. The agricultural census can be useful for classifying holdings by type, as an aid to developing agricultural development policies. For example, holdings can be sub-divided into whether they are subsistence or market oriented, and different policies and programs can be developed for each group.
- Studies of small holdings.

Agricultural census data are suitable for in-depth agricultural research in support of planning and policy-making, involving the use of specialized statistical methods such as correlation and regression analysis. Using these techniques, it is possible to quantify the relationships between different characteristics, to better understand the reasons why farmers make certain decisions, and their likely response to particular policy actions. Agricultural censuses often provide the only way to do this type of analysis due to the availability of individual holding data. For example, regression techniques could be used to study the relationship between good agricultural practices and characteristics such as household size, holder's age, holder's education, and access to extension services, to understand the main factors affecting agricultural practices. The analysis might show that, for example, good agricultural practices are not strongly related to whether the holding used extension services, suggesting the need for strengthening the extension services.

1.7 IMPROVING CURRENT AGRICULTURAL STATISTICS

A decennial agricultural census cannot be used as a source of current agricultural statistics because it is does not provide data frequently enough. However, the agricultural census can provide reliable current data relating to crop and livestock production for the census year, and this can be useful as a benchmark for improving current crop and livestock statistics. The inclusion of crop production data in the program for the first time is a considerable help in this regard.

For crops, the agricultural census usually provides the most reliable data available on the area and production of each crop at each administrative level for the census reference year. This is

especially the case for minor crops, where the current statistics are often weak. The census data could provide a base for estimating crop area and production in the following years. For example, the current crop area could be obtained by estimating the change in the crop area since the census reference year.

Current statistics on permanent crops are often weak because of data collection difficulties, especially for trees not grown in plantations. Census data on production can provide benchmark production figures. Data on the number of productive and non-productive trees can be used to project future production trends.

Current livestock production statistics are often weak because of the lack of data on herd structures. The agricultural census can help in this regard. Census data on livestock numbers by age, sex and purpose, together with data on the population dynamics of livestock herds such as take-off and reproductive rates, can provide a base for projecting livestock numbers in future years for use in estimating milk and meat production.

Often, economies find it difficult to reconcile crop or livestock data from the agricultural census with the current agricultural statistics obtained from sample surveys or administrative collections. Such discrepancies between data from the agricultural census and the current statistics may come down to differences in the data collection methodology and the quality of data associated with each data source. This especially applies where the current agricultural statistics are based on administrative reports. Often, an agricultural census provides the only source of statistically sound data, and economies should take advantage of the opportunity provided by the census to improve the current agricultural statistics.

1.8 PROVIDING BASELINE DATA FOR MONITORING AGRICULTURAL DEVELOPMENT PROJECTS

Typically, an agricultural development project aims to achieve certain outcomes in a defined project area. Baseline data are needed to help assess whether the project has been successful. An agricultural census provides detailed structural data for small geographic areas, making it an ideal source of baseline data.

Agricultural censuses can be tabulated for any defined geographic area or for any particular group of holdings, which means that it can provide data for any required target group for a project. For example, if a project is designed to improve coffee growing in a particular project area, census tables can be prepared showing data for coffee growers in that specific area.

1.9 PROVIDING DATA FOR THE PRIVATE SECTOR

As well as providing data for government planning and policy-making, an agricultural census is also a valuable source of data for the private sector. The main interest for the private sector is usually in data to help make commercial decisions. A food processing company could use agricultural census data on the number of growers and area for specific crops in each district to help identify suitable sites for its processing plants. An input supplier could use census data on input use for each crop by district to better understand market opportunities. Farm machinery suppliers could make use of data on the area of each type of crop grown and the number of growers to assess the potential demand for their products. A company planning to establish a business in a particular location could use census data to assess the availability of labor and the pool of skills available in that location.

2. Census of Agriculture: Methodological Considerations

This chapter discusses some important methodological issues to be considered in the development of a census of agriculture. The timing and objectives are reviewed, and the scope of the census is discussed. The concepts of agricultural holding and agricultural holder are reviewed and two new items introduced, i.e. the sub-holding and the sub-holder. Options for the frame for the census of agriculture and the use of complete or sample enumeration are discussed. The steps involved in developing and undertaking an agricultural census are also summarized.

2.1 TIMING

The original World Census of Agriculture for 2010 (WCA 2010) covers the ten-year period 2006–2015. Economies are encouraged to carry out their agricultural census as close as possible to the year 2010, to help to make international comparisons more meaningful, while recognizing that the timing of an economy's census is determined by many factors, including administrative and financial considerations.

In particular, economies should take into consideration the timing implications imposed by the population census, especially where the two censuses are to be coordinated. In the population census program, it is recommended that economies undertake their censuses in years ending in "0" or as near to those years as possible. Many economies adhere to that recommendation. There are many advantages in conducting the agricultural census at the same time as, or soon after, the population census, especially as agriculture related data and field materials will still be current.

2.2 OBJECTIVES

In the past, the census of agriculture has aimed to provide data on the structure of agricultural holdings, with attention given to providing data for small administrative units and other detailed cross-tabulations of structural characteristics. Agricultural censuses have also been used to provide benchmarks to improve current crop and livestock statistics and to provide sampling frames for agricultural sample surveys. Previous agricultural censuses have focused on the activities of agricultural production units; that is, households or other units operating land or keeping livestock. They have not been seen as censuses of rural households.

The basic objectives of the census of agriculture have remained relevant over the past few agricultural census rounds. One development since the 2000 agricultural census program has been the MDG framework for sustainable economic development. Economies are giving increasing emphasis to monitoring progress towards the Millennium Development Goals

(MDGs), and the agricultural census is seen as an important source of data for this purpose. There has also been more focus on poverty alleviation. An additional objective has been included to reflect this emphasis. For WCA 2010, the objectives of the agricultural census are:

- To provide data on the structure of agriculture, especially for small administrative units, and to enable detailed cross-tabulations.
- To provide data to use as benchmarks for current agricultural statistics.
- To provide frames for agricultural sample surveys.
- To provide data to help monitor progress towards global development targets, in particular the MDGs.

2.3 SCOPE AND COVERAGE

Broadly speaking, an agricultural census aims to measure the structure of the agricultural production industry. The scope of the agricultural production industry could be interpreted very broadly to cover not only crop and livestock production activities, but also forestry and fisheries production activities, as well as other food and agriculture related activities. Past agricultural census programs have taken a narrow view of agriculture by focusing only on those units engaged in the production of crop and livestock products. Units engaged in forestry or fisheries were not covered unless they also had some crop or livestock production activities.

For the 2010 round of agricultural censuses, it is recommended that the scope of the agricultural census remains the same as in previous programs. However, it is recognized that aquaculture is becoming increasingly important in many parts of the world, and economies are encouraged to conduct an aquacultural census in conjunction with the agricultural census, where there is a need for aquacultural data. Further information on the aquacultural census is given in Chapter 6.

International statistical standards for defining areas of economic activity are given in the International Standard Industrial Classification of all Economic Activities (ISIC) (UN, 2004b). For more information on ISIC, see Appendix 1[5]. The scope of an agricultural census may be defined under ISIC (Rev. 3.1) as follows:

- Group 011: Growing of crops; market gardening; horticulture.
- Group 012: Farming of animals.
- Group 013: Growing of crops combined with farming of animals (mixed farming).

Ideally, an agricultural census should cover all agricultural activity in an economy according to the above ISIC groupings. In the past, a minimum size limit for inclusion of units in the census or exclusion of certain areas such as urban centers is justified on the grounds that there are usually a large number of very small holdings making little contribution to total agricultural production and it is not cost-effective to include them in the agricultural census. However, small-scale agriculture makes a significant contribution to household food supplies

[5] *A system of integrated agricultural censuses and surveys – Volume 1 World Programme for the Census of Agriculture 2010*, FAO Statistical Development Series, Rome, 2005.

and is often an important source of supplementary household income, and in some economies almost all households have some agricultural production activities that require recognition. The inclusion of small holdings is also important to reflect women's participation in agricultural work.

Various criteria may be used to establish minimum size limits, such as: area of holding, area of arable land, area of temporary crops, number of livestock, number of livestock over a certain age, quantity of output produced, value of agricultural production, quantity of labor used, and quantity of produce sold. Sometimes, the scope of the agricultural census is restricted to commercial agricultural activities, omitting households with a small area of crops used solely for home consumption. Minimum size limits are often difficult to apply. For livestock numbers, one needs to have complex criteria involving numbers of each type of livestock. For example, one may wish to omit households with less than 20 chickens or with less three pigs, but what if a household has 18 chickens and two pigs? Setting a minimum value of agricultural production is difficult to apply, especially where a large part of the agricultural output is for the household's own consumption.

An alternative to minimum size limits is to cover all units regardless of size, but ask only some very limited questions for small units. This is easy to do where, as is often the case, the frame for an agricultural census is a list of households and some initial questions are needed to screen out those who are not agricultural holdings. Here, the following approach could be used:

- First, ask questions about crops and livestock needed to identify all agricultural production units, regardless of size. Collect some basic information for those units.
- Second, ask some additional questions to identify those agricultural production units above the minimum size limit. Proceed to ask the more detailed questions for those units.

Sometimes, economies omit certain areas of the economy or certain types of agricultural activity – such as remote areas or areas with security problems – for operational reasons. Economies should decide on any out-of-scope areas according to local conditions, making sure that the usefulness of the census is not jeopardized. For example, omitting remote desert regions may result in missing important livestock resources, such as in nomadic areas. Sometimes, it might be appropriate to cover only the household sector, if it is dominant in agriculture. Often, agricultural activities of the military are excluded; sometimes, schools and religious organizations are also omitted.

Usually, it is not possible to cover all agricultural activity in an agricultural census for one reason or another. In planning the agricultural census, economies should be realistic about what can be done within available budgets and staff resources, and ensure that what is done is done well. It should be recognized that, in an integrated agricultural statistics system, any exclusions from the agricultural census affects not only the results of the agricultural census, but also the surveys that are conducted based on the agricultural census. Thus, an agricultural production survey based on an agricultural census frame will not cover the census out-of-scope units, and agricultural production estimates from the survey will be affected accordingly.

Economies should clearly specify the scope in the presentation of agricultural census results. Where certain geographic areas or types of agricultural activity are excluded, this should be highlighted in the census reports to help users interpret and analyze the results.

2.4 CONTENT

The modular approach for the census of agriculture envisages a core census module based on complete enumeration to collect key data, and a series of sample-based supplementary modules to collect more in-depth data. A list of recommended core items is shown in Chapter 4, along with a list of optional items for inclusion in the supplementary modules, as required. Items have been selected as being suitable for the core module on the basis of the following criteria:

- The items are the key items needed for agricultural policy-making and planning.
- Data for the items are required to be produced for small administrative units such as districts or villages, or in the form of detailed cross-tabulations. Such data could not be provided from an agricultural sample survey because of high sampling errors.
- The data involve the measurement of rare events, such as unusual crops or livestock, which would not be possible to estimate from a sample survey because of high sampling errors.
- The data are required to establish sampling frames.
- The data are required to make international comparisons.

In developing its census of agriculture, an economy should include in the core census module all recommended census core items, plus additional items from the list of supplementary items according to domestic requirements.

One reason an economy might include additional items in the core module is because detailed geographic data are needed. For example, if livestock numbers by age and sex are needed at the district or village level, these items may need to be included in the core module, rather than a supplementary module. Economies should carefully consider the suitability of each item for the core census module and the costs involved. For example, education data are of interest in an agricultural census to broadly analyze the relationship between education and farm characteristics, not to measure education levels as in a population census, and this item is therefore better suited to a supplementary module.

Another possible reason to include additional items in the core census module is to provide data to help create sampling frames for the census supplementary modules and for the program of agricultural surveys. Where possible, economies should plan their agricultural survey program prior to the agricultural census to ensure that the census can be designed to meet the sampling frame needs. For example, if an in-depth fertilizer survey was to be conducted, a fertilizer usage item could be included in the core census module for sampling frame purposes.

Economies should carry out one or more census supplementary modules according to the domestic requirements, based on the list of items provided. Additional items may be added as required. Several modules may be combined into a single survey.

Some further issues for consideration in deciding on the content of the agricultural census are:

- The data needs of agricultural policy-makers and planners. The agricultural census should be developed specifically to meet the needs of agricultural policy-makers and planners. Data requirements will be different in each economy, depending on the policy issues and priorities.
- The suitability of the census vehicle for the collection of the data required. An agricultural census is intended to collect structural data and the items included should focus primarily on those types of data. Operational data are usually not suited to an agricultural census. Items requiring in-depth questions, such as cost of production, are also best collected in other agricultural surveys.
- The technical, operational and financial resources available to undertake the census. Conducting censuses is not only costly but also requires considerable human resources for the development, data collection and data processing. Economies need to balance the need for data against the resources available. The ability to produce timely data is an important issue.
- The willingness and ability of the public to supply the information required. Care is needed in the selection of items and the design of questionnaires to ensure that reliable data can be collected from respondents. Some items may be sensitive because of cultural or economic reasons – for example, respondents are sometimes reluctant to supply land data because they fear it may have taxation consequences.
- The data collected in previous rounds of the agricultural census. Collecting the same data as in past censuses can be valuable in tracking changes in the structure of agriculture over time. However, items should not be automatically carried over from one census to the next without reviewing their continuing relevance to current data needs and the suitability of the concepts and definitions used.
- The need for data for international comparisons. The 16 recommended core items will provide the basis for FAO to make a global assessment of agricultural holdings. FAO recommends that all economies collect these items so that international comparisons can be made.

2.5 STATISTICAL UNIT

The statistical unit for a data collection is the basic unit for which data are collected. In previous agricultural census programs, the statistical unit used has been the agricultural holding and this is used again in WCA 2010.The definition of an agricultural holding remains the same as in previous programs; that is:

> "An agricultural holding is an economic unit of agricultural production under single management comprising all livestock kept and all land used wholly or partly for agricultural production purposes, without regard to title, legal form, or size. Single management may be exercised by an individual or household, jointly by two or more individuals or households, by a clan or tribe, or by a juridical person such as a corporation, cooperative or government agency. The holding's land may consist of one or more parcels, located in one or more separate areas or in one or more territorial or administrative divisions, providing the parcels share

> the same production means, such as labor, farm buildings, machinery or draught animals."[6]

There are two types of agricultural holdings: (i) holdings in the household sector – that is, those operated by household members; and (ii) holdings in the non-household sector, such as corporations and government institutions. In most economies, the majority of agricultural production is in the household sector. The concept of "agricultural holding" is therefore closely related to the concept of "household".

The household is one of the basic elements of a national statistics system and standards for defining a household have been laid down by the United Nations in its guidelines for population and housing censuses as follows:

> "The concept of household is based on the arrangements made by persons, individually or in groups, for providing themselves with food or other essentials for living. A household may be either (a) a one-person household, that is to say, a person who makes provision for his or her own food or other essentials for living without combining with any other person to form part of a multi-person household, or (b) a multi-person household, that is to say, a group of two or more persons living together who make common provision for food or other essentials for living. The persons in the group may pool their incomes and may, to a greater or lesser extent, have a common budget; they may be related or unrelated persons or constitute a combination of persons both related and unrelated."[7]

A household may occupy the whole of a dwelling, part of a dwelling, or more than one dwelling.

There may be more than one household living in a dwelling. For the household sector, all the agricultural production activities by members of a given household are usually undertaken under single management. Even if there is a degree of independence in the agricultural activities of individual household members, the income or produce generated by different household members is usually pooled. Often, different members of the same household own land, but usually the agricultural operations in the household are carried out as a single unit under the head-of-household.

There are two special cases where the agricultural holding and household concepts may diverge:

- If there are two or more units making up a household, such as where a married couple lives in the same dwelling as their parents, the two units may operate land independently but, as members of the same household, they make common arrangements for food and pool incomes.
- In addition to an individual household's agricultural production activities, a household may operate land or keep livestock jointly with another household or group of households. Here, there are two agricultural holding units associated with the household: (i) the agricultural production activities of the individual household itself; and (ii) the joint agricultural operations with the other household(s).

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[6] Principles and Recommendations for Population and Housing Censuses, Revision 1. *United Nations*, New York, 1998.

[7] Ibid.

In the past, some economies have found it difficult to strictly apply the agricultural holding concept in the agricultural census and, instead, have defined the agricultural holding to be equivalent to a household with own-account agricultural production. Usually, there is little difference between an agricultural holding and a household with own-account agricultural production. Equating the agricultural holding and household units has several benefits:

- The identification of the holding in the agricultural census would be simplified; it would no longer be necessary to find out about the management of the household's own-account agricultural production activities.
- It would bring the concept of agricultural holding into line with the practice already used in previous agricultural censuses in many economies.
- The use of a common statistical unit – the household – would enable the agricultural census to be more easily linked to the population census.
- It would facilitate the analysis of household characteristics.
- If the scope of the agricultural census was expanded to also include other households not engaged in own-account agricultural production, there would be a common unit between agricultural production units and other households.

Economies should consider the advantages of defining the agricultural holding unit in this way, taking account of operational considerations and the issues mentioned above. The definition of the holding should be clearly stated in the presentation of census results to help in the interpretation of data.

The following additional points relate to the identification of an agricultural holding:

- Agricultural holdings may have no significant land area; for example, poultry hatcheries or holdings keeping livestock for which land is not an indispensable input for production.
- Agricultural holdings may be operated by persons who do not have any rights to agricultural use of the land except for the products of the trees grown on it (tree holdings).
- If a member of a cooperative, religious organization, government agency, clan or tribe is assigned a separate unit for agricultural production that is operated under the member's management, and over which the member has general, technical and economic responsibility, then this unit represents a holding.
- Open rangeland (such as land open to communal grazing) is not normally considered a holding. A specified area delimited by fencing, or any other form of boundary demarcation may be an exception.

Normally, an agricultural holding is defined according to whether the unit is an agricultural production unit at the time of the agricultural census. However, there are some special cases for holdings in the household sector.

- If a household sold all its land and livestock during the census reference year, it is no longer an agricultural production unit and therefore does not represent an agricultural holding. The household that is operating the land and livestock at the time of the census represents the agricultural holding and, moreover, should report all crop and

livestock activities during the reference year, including activities carried out prior to the sale. This can be difficult to apply.

- If a household leases land to grow crops in a particular season, but the census is undertaken in a different season, the household should be considered as an agricultural holding, even though it is not engaged in agricultural production activities at the time of the census. Here, the household should report crop activities during the reference year in the normal way.
- Sometimes, a household owning a piece of land may operate the land itself during the summer season, but rent it out to another household to cultivate during the winter season. Here, the piece of land should be reported as part of the area of holding for both households. This results in some double counting of land.

2.6 AGRICULTURAL HOLDER

The agricultural holder is defined as the civil or juridical person who makes the major decisions regarding resource use and exercises management control over the agricultural holding operation. The agricultural holder has technical and economic responsibility for the holding and may undertake all responsibilities directly, or delegate responsibilities related to day-to-day work management to a hired manager.

By definition, the agricultural holding is under single management, and a joint holder or head-of-household is a person making the major decisions regarding resource use and exercising management control over the agricultural holding operations. The concept of an agricultural holder is often difficult to apply because of the complex decision-making processes on the holding. Often, a holding is managed jointly by members of the household, such as a husband and wife. If there is one person making the major decisions, he/she should be defined as the holder. If more than one person is involved in major decision-making, each of those persons should be considered as a joint holder. If there are two quite distinct agricultural management units in a household, the household should be split into two agricultural holdings. The agricultural holder is often, but not always, the household head. The agricultural holder may do other work in addition to being a holder; being a “farmer” may not even be his/her main occupation. A distinction should be made between an agricultural holder and a hired manager; a hired manager is a paid employee who manages an agricultural holding on behalf of the agricultural holder.

Some economies may wish to provide more detailed information on the management of the holding. The sub-holding and sub-holder concepts have been introduced in WCA 2010 to reflect this need.

Economies need to carefully consider how best to collect agricultural holder information in the agricultural census. Care is needed to differentiate between the household head and the agricultural holder; often cultural factors influence who is determined to be the household head – sometimes, it is the oldest male – and that person may not be actively involved in the household’s agricultural operations. Often, a single question on who is the main decision-maker for the holding is insufficient, and it may be necessary to ask a series of questions about each household member, their work on the holding, and their role in managing the holding. Special attention needs to be given to ensuring that the role of women is adequately acknowledged in identifying the agricultural holder. As with all data collection,

questionnaires must be carefully designed and tested, and enumerators well trained and closely supervised.

2.7 SUB-HOLDING AND SUB-HOLDER

The concept of an agricultural holder as the major decision-maker for the holding may not provide a realistic picture of the often complex decision-making processes of the holding. Often, different members of the household take responsibility for managing particular aspects of the operations of the holding. Sometimes, women carry out specific activities such as cultivating particular land plots or managing particular livestock activities. There may also be different levels of management; for example, one person may make the strategic decisions ("this year we plant potatoes"), while other people are responsible for operational decisions such as when to plant, who to employ, and how to market.

Some economies may feel that the concept of agricultural holder alone does not adequately reflect the management of the holding, and, in particular, fails to recognize the role of women in managing agricultural activities. To overcome this problem, the concepts of "sub-holding" and the associated "sub-holder" have been introduced in WCA 2010.

A sub-holding is defined as a single agricultural activity or group of activities managed by a particular person or group of persons in the holder's household on behalf of the agricultural holder. There may be one or more than one sub-holding in a holding. A sub-holding could comprise a single plot, a whole field, a whole parcel, or even the whole holding. A sub-holding could also be a livestock operation associated with a plot, field or parcel, or a livestock operation without any land.

A sub-holder is a person responsible for managing a sub-holding on the holder's behalf. There is only one sub-holder in a sub-holding, but there may be more than one sub-holder in a holding. The holder may or may not be a sub-holder. The sub-holder concept is broadly similar to the concepts of "plot manager" and "farm operator" used in some economies.

A typical situation is where the holder is designated as a male and takes prime responsibility, as a sub-holder, for growing the primary crops. The holder's wife may be a second sub-holder, with specific responsibility for managing, for example, the kitchen garden. Other household members could also be sub-holders with specific responsibilities on the holding, such as livestock.

The sub-holding/sub-holder concepts are complex, involving notions of management, decision-making and delegation of authority. They will not be suitable for all economies. However, economies wishing to bring a gender perspective to the agricultural census will find these concepts provide a useful basis for measuring the role of women in agriculture. The two concepts are very broad and economies will be able to adapt them to fit domestic circumstances and data requirements.

Economies will need to put considerable effort into developing suitable data collection methods and questions to identify sub-holdings and sub-holders in the agricultural census. The approach used by an economy will depend on domestic agricultural practices and social and cultural conditions, taking into consideration the data collection methodology used for the rest of the agricultural census. Usually, a series of questions about each household member

will be needed, to find out about the types of work each carried out on the holding and their role in managing agricultural production activities.

Data on sub-holdings and sub-holders are recommended for inclusion in the supplementary component of the agricultural census under Category 12: Management of the holding.

2.8 AGRICULTURAL CENSUS FRAME

In a statistical collection, the frame is the means by which the statistical units to be enumerated in the collection are identified; in this case, agricultural holdings. An ideal frame would be a list of all agricultural holdings, identifying each unit without omissions or duplications and without any units other than agricultural holdings. Such a list could be obtained through a population census, a farm register, or another source.

Where a farm register exists, it can be a good frame for an agricultural census provided it is regularly updated to remove units that cease to operate as holdings and to add new holdings. Usually, a register contains some basic information about each unit, such as some sort of size measure, which is updated periodically. Farm registers can be created in different ways. Sometimes, they are initially created at the time of an agricultural census and regularly updated thereafter using information from various sources.

For non-household agricultural holdings, frames may exist in the form of records from government regulatory agencies. Most economies have a business registration or licensing system. Membership information from industry associations may also be useful. Such frames can also be created by asking local officials to provide lists of agricultural units in their area of responsibility.

One problem with frames based on farm registers is that they are often established for administrative purposes and therefore may not be compatible with statistical needs. The unit on the register often does not correspond with the agricultural holding unit for the agricultural census. For example, the register may be based on cadastral or other land records where each parcel of land is identified, rather than the holding unit. Also, registers are usually based on land ownership, which is not always suitable to an agricultural census because several people in a household may own land separately. Also, the land owner is not the land operator if the land is rented out. Frames based on business registration or licensing procedures are not always suitable as they represent what the business is licensed to do, not what they actually do.

Another type of frame for the household sector of an agricultural census is one created from the population census as a one-time exercise, without it being kept up-to-date or maintained as a farm register afterwards. The population census could include additional questions on agriculture to help identify agricultural holdings for the agricultural census. Alternatively, the identification of agricultural holdings in the household sector could be carried out as part of the cartographic work or pre-census listing exercise. For such a frame to be useful, the agricultural census would need to be undertaken as soon as possible after the population census to ensure that the list of agricultural holdings is accurate.

Another consideration with frames based on the population census is the statistical unit. Even if additional questions on agriculture are included in the population census or pre-census listing exercise, the frame would typically identify households engaged in own-account

agricultural production, not agricultural holdings. Such frames may still be useful for enumeration of the agricultural census as follows: (i) contact each household with own-account agricultural production for the agricultural census; (ii) ask each household with own-account agricultural production about the management of agricultural activities in the household to identify each agricultural holding; and (iii) enumerate all agricultural holdings for the agricultural census.

Even a list of all households from the population census can provide a useful frame for an agricultural census, as follows: (i) contact each household for the agricultural census; (ii) ask each household about the household's own-account agricultural production activities and the management of agricultural activities in the household, to identify each agricultural holding; and (iii) enumerate all agricultural holdings for the agricultural census.

Where a frame of agricultural holdings, households with own-account agricultural production, or households is unavailable from an existing farm register or the population census, it is usually not worthwhile creating a frame in this form just for the agricultural census. Instead, a different type of frame is used. First, the economy is divided into suitable geographical units, called enumeration areas (EAs), covering the whole in-scope domestic territory. Then, each EA is visited to identify all agricultural holding units through interviews with local authorities or visits to each household. Population censuses are usually done using this type of frame and it is often possible for the agricultural census to piggyback onto the population census field system by using the same EAs and making use of maps and other field materials.

An EA is a geographical unit of suitable size to organize the census data collection – typically, 50 to 100 households. An EA could correspond to existing administrative units, such as villages. Often, it is necessary to subdivide administrative units to form suitable sized units. This is done by examining existing maps and administrative records, with field inspection undertaken as required. Aerial photographs and satellite imagery can also be useful in forming EAs.

Typically, a combination of frames is used for the agricultural census. Often, the household sector is enumerated based on the population census EA frame, whereas a frame of agricultural holdings in the non-household sector is obtained from administrative sources.

Care is needed in establishing frames for the agricultural census to ensure that all agricultural production units are covered. If agricultural holdings are missing from the frame, they will not be enumerated in the agricultural census and the validity of the census results will be compromised. This is especially important in an integrated agricultural statistical system, as any weaknesses in the agricultural census frame will be reflected in all the surveys that follow.

2.9 COMPLETE CENSUS ENUMERATION VERSUS SAMPLE SURVEY METHODS

From the start, agricultural censuses were intended to be censuses in the traditional statistical sense; that is, a complete enumeration of all agricultural holdings in an economy. Complete enumeration collections are costly and difficult to manage in comparison to a sample survey. However, there are advantages for using a complete enumeration approach of an agricultural census:

- (a) Data estimates can be produced for small administrative units that are usually not possible from sample surveys because the sample estimates at this level are based on small sample sizes and are therefore subject to large sampling error.
- (b) A census enables more detailed cross-tabulations to be produced than is possible from a sample survey because of large survey sampling errors.
- (c) A census can measure rare events such as the area of rarely grown crops or the number of infrequently occurring types of livestock. In a sample survey, few of these cases would be picked in the sample and therefore the data would be subject to large sampling errors.

In recent years, many economies have carried out the agricultural census using a sampling approach, and this has limited the amount of disaggregated and other finely-classified data able to be produced. Usually, sample sizes have been large enough to retain many of the attributes associated with a full census.

WCA 2010 provides for a combination of complete enumeration and sample methods. Complete enumeration in the core census module is needed to provide the detailed data for the key items, as well as sampling frames. However, it is recognized that it may not be possible for some economies to use complete enumeration, even for a limited set of key items, and sampling methods may need to be employed.

2.10 AGRICULTURAL CENSUS REFERENCE PERIOD

The census reference period is a period of twelve months, usually either a calendar year or an agricultural year, generally encompassing the various time reference dates or periods of data collection for individual census items. This reference period applies to both the core and supplementary modules of the agricultural census. Other agricultural surveys can be undertaken any time after the census.

The reference period for agricultural census items varies according to the type of data. The reference periods are usually the day of enumeration (for inventory items) or a twelve-month reference period (for continuing activities). The agricultural year is usually the most suitable reference period because respondents find it easier to think of their agricultural activities in terms of seasonal activities.

Sometimes, the agricultural census is carried out over an extended period of time, because of a shortage of enumerators or other field staff. Certain regions of an economy may be enumerated at different times of the year because of seasonal and agricultural conditions. Economies need to establish suitable census reference periods to deal with these problems.

2.11 FIELD ORGANIZATION OF CENSUS CORE AND SUPPLEMENTARY MODULES

The core and supplementary module(s) can be implemented as part of a single data collection operation, with the enumerator interviewing each holder to collect data for both the core and supplementary census modules at the same time. This may be done using a single questionnaire or separate questionnaires for each module. Typically, the enumerator’s job is to:

- Collect data for the core census module.

- Apply specific sampling procedures, based on responses to the core census questions, to determine whether the holding is included in the supplementary module(s). A separate sampling scheme is used for each module. For example, with supplementary modules on aquaculture and livestock, the sampling procedures might require that, in certain pre-assigned sample EAs, each holding with aquaculture is included in the aquacultural module and each holding with livestock is included in the livestock module.
- If the holding is included in the sample for the supplementary module(s), proceed to ask the additional questions required for the supplementary module(s). Otherwise, the interview is finished.

Alternatively, the core and supplementary module(s) can be done separately. Here, the core census is undertaken first, with the core questionnaires being returned to the office for use in selecting the sample for the supplementary modules. Enumerators then return to the field to carry out the census supplementary module(s). In cases where the supplementary modules are carried out over a period of time, some updating of the census frame may be necessary, in advance of the field work.

2.12 STEPS IN DEVELOPING AN AGRICULTURAL CENSUS

Information on how to develop and conduct an agricultural census is given in *Conducting Agricultural Censuses and Surveys* (FAO, 1996a). The basic steps are:

- Determine the overall strategy for the agricultural census as part of the system of integrated agricultural censuses and surveys.
- Define the objectives of the agricultural census.
- Develop a work plan and budget for developing and carrying out the census.
- Prepare census legislation, if required.
- Form a National Census Committee to oversee the census.
- Develop and implement the census publicity campaign.
- Create the Agricultural Census Office and recruit the necessary staff.
- Prepare frames.
- Prepare maps for census field operations.
- Develop the tabulation plan.
- Design and test questionnaires.
- Design and test the computer processing system, including data entry, editing and tabulation.
- Prepare field instruction manuals.
- Develop the field system; recruit and train field staff.
- Census enumeration.
- Data processing.
- Undertake quality control checks on the data.
- Tabulate and analyze the data.
- Prepare census reports and disseminate results.
- Reconcile the census data with the data from the system of current statistics.

3. Items for Agriculture Census

This chapter contains recommended items for inclusion in the census of agriculture according to their suitability for the core and supplementary modules. The supplementary items are presented under 12 headings or themes, corresponding to areas of interest for the census supplementary modules. The reference group for each theme is shown, along with cross-references to the concepts and definitions in Annex I.

3.1 INTRODUCTION

This chapter lists the recommended items for the census of agriculture. The list has been prepared by FAO based on experiences of economies with previous agricultural censuses, taking into account agricultural issues and problems faced by economies. The chapter relates only to the core and supplementary modules; items for the community survey are shown in Chapter 4.

The FAO recommends that agricultural censuses for the 2010 round be carried out using a modular approach, with a core census module based on complete enumeration to provide key data, and one or more census supplementary modules to cover more in-depth topics. In this chapter, items are presented under two headings: (i) items recommended for inclusion by all economies in the core census module; and (ii) items to be considered by economies for inclusion in the census supplementary modules. The supplementary items are presented under 12 headings or themes. For information on how economies will choose items for inclusion in their agricultural census, see paragraph 2.4.

For the supplementary modules, the scope of each theme is shown in parenthesis under each heading. For example, the scope of a land supplementary module (Theme 01) would be “holdings with land”, as identified from Item 0008 in the core module. References to the applicable concepts and definitions in Annex I are shown in parenthesis after each item. Items that are new or substantially modified are also highlighted.

3.2 ITEMS RECOMMENDED FOR CORE MODULE

0001 Identification and location of agricultural holding (see paragraphs A.4–A.6).
0002+ Legal status of agricultural holder (see paragraphs A.7–A.10).
0003 Sex of agricultural holder (see paragraphs A.11–A.13).
0004 Age of agricultural holder (see paragraphs A.14– A.16).
0005 Household size (see paragraphs A.206– A.209).
0006 Main purpose of production of the holding (see paragraphs A.173– A.175).
0007 Area of holding according to land use types (see paragraphs A.20– A.39).
0008 Total area of holding (see paragraphs A.40– A.45).
0009 Land tenure types on the holding (see paragraphs A.46– A.52).

0010 Presence of irrigation on the holding (see paragraphs A.68– A.72).
0011 Types of temporary crops on the holding (see paragraphs A.91– A.94).
0012 Types of permanent crops on the holding and whether in compact plantations (see paragraphs A.95– A.98).
0013 Number of animals on the holding for each livestock type (see paragraphs A.148– A.152).
0014 Presence of aquaculture on the holding (see paragraphs A.292– A.296).
0015+ Presence of forest and other wooded land on the holding (see paragraphs A.312– A.313).
0016 Other economic production activities of the holding's enterprise (see paragraphs A.17– A.19).

3.3 ITEMS FOR CONSIDERATION FOR SUPPLEMENTARY MODULES

Theme 01 – Land

(Reference group: holdings with land in Item 0008)

For Each Parcel

0101 Location (see paragraphs A.53– A.55).
0102 Area (see paragraph A.56).
0103 Land tenure (see paragraphs A.57– A.58).
0104 *(For rented parcels)* Terms of rental (see paragraph A.59).
0105 Presence of shifting cultivation (see paragraph A.60– A.61).
0106+ Number of years since cleared (see paragraphs A.62– A.63).

For the Holding

0111+ Presence of soil degradation: type and degree (see paragraphs A.64– A.67).

Theme 02 – Irrigation and Water Management

(Reference groups: Items 0201–0205 – holdings with irrigation in Item 0010; Item 0206 – holdings with temporary crops or permanent crops in Items 0011 and 0012; Item 0207 – holdings with land in Item 0008).

For the Holding

0201+ Area of land irrigated according to land use type (see paragraphs A.73– A.75).
0202+ Area irrigated according to method of irrigation (see paragraphs A.76– A.79).
0203+ Area irrigated for each crop type (see paragraphs A.80– A.81).
0204+ Sources of irrigation water (see paragraphs A.82– A.83).
0205+ Payment terms for irrigation water (see paragraph A.84).
0206+ Other types of water management practices (see paragraphs A.85– A.88).
0207 Presence of drainage equipment (see paragraphs A.89– A.90).

Theme 03 – Crops

(Reference groups: Items 0301–0303 – holdings with temporary crops in Item 0011; Items 0311–0314 – holdings with permanent crops in Item 0012; Items 0321–0327 – holdings with temporary crops or permanent crops in Items 0011 and 0012).

For Each Temporary Crop Type

0301 Area of temporary crops harvested (see paragraphs A.99– A.111).

0302+ (For selected crop types) Area of temporary crops harvested according to end-use (see paragraphs A.112– A.114).

0303+ (For selected crop types) Production of temporary crops harvested (see paragraphs A.115– A.116).

For Each Permanent Crop Type

0311 Area of productive and non-productive permanent crops in compact plantations (see paragraphs A.117– A.121).

0312 *(For tree crops)* Number of permanent crop trees in compact plantations and scattered plantings (see paragraphs A.122– A.123).

0313+ (*For selected crop types)* Area of productive permanent crops in compact plantations according to end-use (see paragraphs A.124– A.125).

0314+ *(For selected crop types)* Production of permanent crops (see paragraph A.126).

For the Holding

0321+ Area of land used to grow temporary crops as a secondary land use (see paragraphs A.127– A.129).

0322 Use of each type of fertilizer (see paragraphs A.130– A.137).

0323+ Area fertilized for each type of fertilizer and major crop type (see paragraph A.138).

0324+ Source of seed inputs for each major crop type (see paragraphs A.139– A.140).

0325+ Type of seed for each major crop type (see paragraphs A.141– A.143).

0326+ Area of nurseries (see paragraphs A.144– A.145).

0327 Area of cropped land under protective cover (see paragraphs A.146– A.147).

Theme 04 – Livestock

(Reference group: holdings with livestock in Item 0013)

For the Holding

0401 Type of livestock production system (see paragraphs A.153– A.155).

0402+ Use of veterinary services (see paragraphs A.156– A.157).

For Each Livestock Type

0411 Number of animals: age and sex (see paragraphs A.158– A.160).

041 Number of animals according to purpose (see paragraphs A.161– A.162).

0413+ Number of milking animals according to milk status (see paragraph A.163).

0414+ Number of animals born (see paragraph A.166).

0415+ Number of animals acquired (see paragraph A.167).

0416+ Number of animals slaughtered (see paragraph A.168).

0417+ Number of animals disposed of (see paragraph A.169).

0418+ Number of animals died from natural causes (see paragraph A.170).

0419 Types of feed (see paragraphs A.171– A.172).

Theme 05 – Agricultural Practices

(Reference group: all holdings)

For the Holding

0501+ Use of agricultural pesticides (see paragraphs A.176– A.177).
0502+ Use of good agricultural practices (see paragraphs A.178– A.179).
0503+ Use of organic agricultural practices (see paragraphs A.180– A.182).
0504+ Use of genetically modified crops according to crop type (see paragraph A.183).
0505 Selected machinery and equipment used on the holding according to source (see paragraphs A.184– A.186).
0506 Non-residential buildings according to use (see paragraphs A.187)
0507+ Percentage of each major agricultural product sold (see paragraph A.188).

Theme 06– Agricultural Services

(Reference group: holdings in sector "single-holding household" in Item 0002)

For the Holding

0601+ Receipt of credit for agricultural purposes (see paragraphs A.189– A.191).
0602+ Source of credit (see paragraph A.192).
0603+ Type of collateral for credit (see paragraphs A.193– A.194).
0604+ Period of loan or credit (see paragraph A.195).
0605+ Sources of agricultural information (see paragraphs A.196– A.197).
0606+ Sources of agricultural extension services (see paragraphs A.198– A.202).
0607+ Travelling time to nearest periodic or permanent agricultural produce market (see paragraphs A.203– A.205).

Theme 07 – Demographic and Social Characteristics

(Reference group: holdings in sector "single-holding household" in Item 0002)

For the Holding

0701+ Whether holding is part of an agricultural household (see paragraphs A.210– A.214).
0702+ Ethnic group of household head or agricultural holder (see paragraphs A.215– A.216).

For each Household Member

0711 Sex.
0712 Age (see paragraph A.217).
0713+ Relationship to household head or other reference person (see para. A.218– A.220).
0714 Marital status (see paragraphs A.221– A.223).
0715 Educational attainment (see paragraphs A.224– A.225).

Theme 08 – Farm Labor

(Reference group: Items 0801–0814 – holdings in sector "single-holding household" in Item 0002; Items 0821–0823 – all holdings)

For Each Household Member of Working Age

0801+ Activity status (see paragraphs A.234– A.240).

For Each Economically Active Household Member

0811+ Status in employment of main job (see paragraphs A.241– A.246).
0812 Occupation of main job (see paragraphs A.247– A.252).
0813+ Time worked in main job (see paragraphs A.253– A.258).
0814+ Time worked on the holding (see paragraphs A.253– A.258).

For the holding

0821 Number of employees on the holding: time worked and sex (see paragraphs A.259– A.264).
0822+ Form of payment for employees (see paragraph A.265).
0823+ Use of contractors for work on the holding according to type (see paragraphs A.266– A.268).

Theme 09 – Household Food Security

(Reference group: holdings in sector “single-holding household” in Item 0002)

For the Household

0901+

(a) Whether household members could not afford to eat what they normally eat at anytime during a twelve-month reference period.
(b) Months in which food shortage occurred.
(c) Reasons for food shortage.
(d) How the household’s eating patterns were affected by food shortage.
(e) Steps taken to alleviate food shortage. (see paragraphs A.275– A.280).

0902+ Whether the household fears a food shortage during a future twelve-month reference period (see paragraphs A.281– A.282).
0903+ Frequency of normally eating selected food products (see paragraphs A.283– A.284).
0904+ Effects of natural disasters (see paragraphs A.285– A.287).
0905+ Extent of loss of agricultural output due to natural disasters (see paragraphs A.288– A.289).

For Children Aged under 5 Years

0911+ Height and weight (see paragraphs 11.290–11.291).

Theme 10 – Aquaculture

(Reference group: holdings with aquaculture in Item 0014)

For the Holding

1001+ Area of aquaculture according to type of site (see paragraphs 11.297–11.300).
1002+ Area of aquaculture according to type of production facility (see paragraphs 11.301–11.306).
1003+ Type of water (see paragraphs A.307– A.308).

1004+ Sources of water for aquaculture (see paragraph A.309).
1005+ Type of aquacultural organism cultivated (see paragraphs A.310– A.311).

Theme 11 – Forestry

(Reference group: holdings with forest and other wooded land in Item 0015)

For the Holding

1101 Area of forest and other wooded land as primary land use (see paragraph A.314).
1102 Area of forest and other wooded land as a secondary land use on agricultural land (see paragraph A.315).
1103+ Main purpose of forest and other wooded land (see paragraphs A.316– A.317).
1104+ Whether agro-forestry is practiced (see paragraphs A.318– A.319).

Theme 12 – Management of the Holding

(Reference group: holdings in sector “single-holding household” in Item 0002)

For Each Holding

1201+ Identification of sub-holdings (see paragraph A.320).
1202+ Identification of sub-holders (see paragraph A.320).

For Each Sub-holding

1211+ Sex of sub-holder (see paragraphs A.321– A.322).
1212+ Age of sub-holder (see paragraphs A.321– A.322).
1213+ Area of crops managed for each crop group (see paragraphs A.323– A.328).
1214+ Number of livestock managed for each livestock group (see paragraphs A.325– A.328).

4. Community-level Data

A new element of the 2010 round of agricultural censuses is the collection of community-level data. This chapter outlines the purpose of collecting community-level data and discusses the items suitable for inclusion in the community survey. Some methodological issues are also discussed.

4.1 INTRODUCTION

Past agricultural census programs have focused on data on the structure of agricultural holdings collected directly from each agricultural holding. These structural data concern matters that are decided upon by the holding, such as what crops to grow and what agricultural inputs to use, and therefore can only be reported by the holding itself, not by public administrations.

However, some types of administrative data are of interest in an agricultural census, especially for decentralized planning, identification of poor villages, planning of targeted area development programs, and targeting communities for relief operations in case of natural disasters. A community-level data collection, often at the village or the commune level, can be useful for examining the infrastructure and services available to holdings. Data on whether the community is prone to natural disasters or subject to seasonal food shortages can be of interest for food security analysis. A community survey may cover agriculture-related data not able to be collected from holdings, such as the area of communal land. Often, the community-level data complements the holding-level data; for example, community-level data on the existence of farmers' associations may complement data on participation in those associations collected from each agricultural holding. For information on previous work done by FAO on community-level statistics, see *Community-level Statistics*[8].

There is a strong demand for community-level data in the agricultural census and, to meet this need, a community-level component has been included in WCA 2010. Economies are encouraged to include this element according to domestic circumstances and data requirements. Community-level data are of statistical interest for three main reasons.

One factor in the collection of community-level data in the agricultural census is that it is usually necessary to make contact with the community administration in carrying out the census fieldwork. Sometimes, the community administration is involved in the census data collection itself or the listing of households or holdings. In these circumstances, community-level data can be collected at little cost.

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[8] Community-level Statistics, FAO, Rome, 1983.

4.2 DEFINING A COMMUNITY

A community can be defined as a self-contained unit of social and economic activities.[9]

Housing censuses use the similar concept of locality, which is "a distinct population cluster that has a name or a locally recognized status" (UN, 1998b, paragraphs 2.49–2.51). Under these definitions, the community or locality may not be the same as the lowest administrative unit. For statistical purposes, the unit chosen for the community survey should take account of operational factors and the circumstances of the economy.

- Data collected. Often, the data requires that the community maintains certain administrative records, which are usually only available for administrative units, commonly the village or commune. Sometimes, the lowest administrative unit has no substantial administrative function, and the community unit may need to be defined at a higher level.
- Cost. The data collection and processing task must be manageable and this may influence whether to collect data at, for example, the commune or village level.
- Identifying community units. Most economies maintain lists of community units down to a certain level. Ready access to such information is needed to do a community survey.
- Stability of community units. In many economies, changes in administrative units are common and not well-coordinated, making it difficult to carry out a community survey.
- Census methodology. If EAs for the census fieldwork are based on the commune unit, for example, it would be easiest to also collect community-level data at that level. Problems may arise if EAs cross locality boundaries.

Deciding on the scope of a community survey is another issue. Normally, economies do not cover all communities in the economy as part of the agricultural census, but limit the collection to those communities containing agricultural holdings. This is convenient operationally as field staff must visit those communities to enumerate the holdings. Covering only rural communities may not be fully satisfactory because some agricultural holdings are in urban areas. Economies should endeavor to cover at least all rural communities.

Community surveys are only applicable in economies with a suitable community-level organization. Sometimes, rural areas are not organized into communities. Even if they are, the communities may not have clear-cut physical boundaries or the community administration may be weak.

4.3 COMMUNITY-LEVEL ITEMS

Many types of data are of possible interest for the community survey, and it is not possible to make specific recommendations on the community-level items each economy should include in its census. Some general guidelines are provided in this section. The content of the community survey should be determined taking into account data needs and the availability of community-level data from other sources.

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[9] Ibid.

Other issues to be considered in deciding on the content of the community survey are:

- The community survey should not be used for collecting holding-level data. The holdings themselves grow crops and raise livestock, and these data should be collected directly from holdings, not by asking a community official to provide estimates. For example, the community administration cannot report on how many people are literate, as it has no way of knowing this information. If these data are required, it is better to directly ask households some literacy-related questions. Note that population by age and sex at the domestic or regional level can be estimated from the holding-level collection, usually more accurately than from community records. This usually applies even if sampling is used.
- The collection of data directly from holdings is one of the features that distinguish an agricultural census from the administrative reporting systems used in many economies. The community survey should not be used to provide a quick and easy method of getting data that are better collected directly from holdings.
- Communities should not be asked to report the same data as holdings, unless the community-level data are required specifically for checking the data reported by holdings. Even here, it is often better to incorporate those data into the holding-level field system than to provide independent community-based data. For example, enumerators could correct area data reported by holdings by referring to the cadastral records.
- Community-level data are only useful if they can be presented in statistical summaries. Emphasis should be given to the tabulation needs in the design of the community survey.
- The community-level items should be limited to key administrative information or aspects of the community that are well-known to people in the community, such as weather conditions, economic activities, and whether certain services exist.
- The number of community-level items should be kept to a minimum, normally, 10-20 items.

A list of possible items for inclusion in the community survey is given below. The list is not exhaustive. Some items may already be available in existing databases and would not need to be collected again in the agricultural census.

Geography

2101 Location
2102 Agro-ecological, climatic, topographical, or soil types
2103 Land use
2104 Area of communal grazing land
2105 Area of communal forest
2106 Travelling time to the nearest major urban center (by season, if applicable)
2107 Whether the community has year-round access to the nearest urban center by a passable road
2108 Whether the community is prone to natural disasters, such as droughts and floods (if applicable)

Socio-economic conditions

2201 Population according to different population groupings
2202 Number of households
2203 Economic status (if applicable)
2204 Economic activities
2205 Whether there are seasonal food shortages (if applicable)

Community infrastructure and services

2301 Presence of a fertilizer dealer; if not, travelling time to the nearest fertilizer trading center (by season, if applicable)
2302 Presence of a pesticides dealer; if not, travelling time to the nearest pesticides trading center (by season, if applicable)
2303 Presence of a seed dealer; if not, travelling time to the nearest seed trading center (by season, if applicable)
2304 Presence of a credit institution; if not, travelling time to the nearest credit institution (by season, if applicable)
2305 Presence of irrigation facilities
2306 Area equipped for irrigation
2307 Availability of veterinary services; if not, travelling time to the nearest veterinary services (by season, if applicable)
2308 Presence of a periodic or permanent agricultural produce market; if not, travelling time to the nearest periodic or permanent agricultural produce market (by season, if applicable)
2309 Existence of agricultural produce collection network
2310 Presence of food storage facilities.
2311 Presence of agricultural processing facilities
2312 Presence of facilities for maintaining agricultural machinery
2313 Existence of farmers' associations, cooperatives, and other bodies providing support and services to farmers.
2314 Availability of agricultural extension service
2315 Whether electricity is connected
2316 Presence of a primary school; if not, travelling time to the nearest primary school (by season, if applicable)
2317 Presence of a health facility; if not, travelling time to the nearest health facility (by season, if applicable)
2318 Presence of radio, telephone, and Internet services
2319 Availability of public transport: bus, train, boat

Development programs

2401 Presence of specific development projects in the community

4.4 CONCEPTS AND DEFINITIONS FOR COMMUNITY- ITEMS

Location (Item 2101) is normally based on a geographic coding system (see paragraphs A.4–A.6). This item is needed to summarize the data by geographical groupings, to relate the data to holding-level data, and to link community databases.

Agro-ecological, climatic, topographical, or soil types (Item 2102). Economies may have one or more standard groupings of areas, which may reflect different agricultural conditions, climatic conditions, or even living standards and ethnic groups.

Land use (Item 2103) should be compatible with the classification used in the holding-level collection (see paragraphs A.20– A.39). Land use data at the community level may be shown in more detail, such as showing land under water or identifying different forest types. Land use at the community level provides a comprehensive picture of all land in the community, not just the land operated by holdings as obtained in the holding-level collection.

Area of communal grazing land (Item 2104) and area of communal forest (Item 2105) help to fill in the gaps from the holding-level collection.

Travelling time to the nearest major urban center (Item 2106) provides a good picture of the isolation of the community, and the effect this has on people's agricultural practices and living standards. Travelling time may differ between seasons, such as during the wet and dry seasons. The related item whether the community has year-round access to the nearest urban center by a passable road (Item 2107) helps to highlight the transportation problems faced by people in the community.

Whether the community is prone to natural disasters (Item 2108) is important for economies that face regular crises because of flooding or other natural disasters. This is often a major cause of food insecurity and may influence farmers' agricultural practices.

Population according to population group (Item 2201) can be useful in classifying the community by type, such as according to ethnic group. Population data can also be useful for providing population-based estimates based on the community-level data. Number of households (Item 2202) is used to provide household-based estimates for community-level data.

Economic status (Item 2203). In some economies, each community is assigned an economic status measure, which can be useful to analyze holding-level characteristics in relation to whether the community is "rich" or "poor".

Main economic activities (Item 2204) should be based on the classification of activities used in Item 0016 of the holding-level collection.

Whether there are seasonal food shortages (Item 2205) is suitable for economies where seasonal factors affect food supplies.

Community infrastructure and services (Items 2301–2319). Economies should choose items suited to domestic conditions. The key for these items is whether people have ready access to specific infrastructure and services in the community itself or in a nearby center; hence, the travelling time component in many items.

Presence of specific development projects in the community (Item 2401). This item is of interest where specific government or other development programs are implemented to raise living standards or for agricultural development. These programs might be administered by the government, non-government organizations, international agencies, or on a bilateral basis. The data provided are of interest to evaluate the benefits of those programs.

4.5 METHODOLOGICAL CONSIDERATIONS

The approach used for the collection of community-level data in the agricultural census will depend on the organization of fieldwork for the collection of holding-level data. The fieldwork for an agricultural census is usually organized by dividing the economy into suitable EAs. The EAs often correspond with administrative units such as villages, but this may not always be the level at which community-level data are required. Often, administrative units are sub-divided to form suitable sized EA units, making it difficult to coordinate the community- and holding-level collections.

Where the community administration prepares the list of households or holdings for the agricultural census, it may be possible to administer the community questionnaire at the same time. Often census field staff visits each community to obtain the household/holding list. This can provide a good opportunity to collect the community-level data.

Even if the community administration does not do the household/holding listing, it may be involved in the holding survey operation itself. Often, community officials are used to help locate each household. Sometimes, they help in interviewing households – for example, as translators. In these circumstances, the community questionnaire can be administered at a suitable time.

Consideration should be given to the suitability of collecting community-level data by mail, rather than by interview. The data collected should be simple enough for the community administrations to fill out the questionnaire themselves. Costs may be a factor in this regard.

Sampling methods will usually not be suitable for the community survey. If the core census module is done on a complete enumeration basis, the community survey should be done the same; to do a sample community survey in conjunction with a full enumeration core census of holdings would make it impossible to link holding-level and community-level data in all cases. This would limit the usefulness of the community-level data for census analysis purposes.

However, sampling methods may be suitable where the core module is done on a sample basis. In a typical sample-based core module, a sample of EAs is selected, household/holding lists are prepared for each sample EA, and then a sample of households/holdings is enumerated for the census. The same sample areas could be used for the community survey, on the basis that those EAs not selected in the sample are not contacted at all during the collection of holding-level data and would require a special visit to collect the community-level data. A sample community survey would be suitable for analyzing holding-level data in relation to community-level data; as such analysis only requires community-level data from the communities containing the sample holdings. However, the sampling approach may not be suitable for summarizing community-level data.

5. Relationship of Agriculture Census to Population Census

A feature of WCA 2010 is the emphasis on coordinating the census of agriculture with other censuses, especially the population census. This chapter highlights the ways in which this can be done. Attention is given to the use of common definitions and classifications, sharing operational materials, use of the population census as a frame, synchronizing the two data collection operations, collecting additional agricultural data in the population census, and linking data from the two censuses. Coordination with housing and economic censuses is also discussed.

5.1 RELATIONSHIP WITH POPULATION CENSUS

5.1.1 Introduction

A population census is one of the most important statistical collections undertaken by an economy. It provides the major source of basic information on the population of an economy, its geographical distribution, and characteristics such as sex, age, marital status, fertility, education and economic activity. Population censuses enumerate all people in the economy to collect these data. Normally, they are undertaken every ten years.

Guidelines for population and housing censuses are issued by the United Nations. The latest guidelines (UN, 1998) provide a set of “basic” topics, covering items included by most economies in their population censuses, such as sex, age, marital status, activity status and education. Some “optional” topics, such as income, are also included.

5.1.2 Options for Coordinating Agricultural and Population Censuses

In many developing economies, households and agricultural holdings are closely related, because most agricultural production activities are in the household sector. This provides the opportunity for coordination between the two census activities in ways that can save costs and enhance the usefulness of the agricultural census data. This can take several forms:

- Use of common concepts, definitions and classifications (see paragraph 5.1.4);
- Sharing field materials (see paragraphs 5.1.5);
- Using the population census as a household frame for the agricultural census (see paragraph 5.1.6);
- Making use of agriculture-related data from the population census (see paragraphs 5.1.7);

- Collecting additional agriculture-related data in the population census (see paragraphs 5.1.8);
- Linking data from the two censuses (see paragraphs 5.1.9);
- Conducting the two censuses as a joint field operation (see paragraphs 5.1.10).

Because population censuses cover households and not enterprises, the relationship between the agricultural and population censuses applies only to the household sector. Separate frames for the non-household based agricultural holdings will need to be complied as a separate exercise.

5.1.3 Statistical Units in Agricultural and Population Censuses

The primary statistical unit for a population census is the household, whereas for an agricultural census it is the agricultural holding. Normally, there is only one agricultural holding in a household, but there can be two or more holdings in a household or two or more households operating a holding.

Equating the agricultural holding unit with the household unit is not essential to be able to relate the two census activities. Nevertheless, economies sometimes define the agricultural holding to be equivalent to the household to simplify the agricultural census field procedures.

5.1.4 Use of Common Concepts, Definitions and Classifications

The use of common statistical standards in the agricultural and population censuses ensures that data from the two sources are consistent and comparable, making it easier to analyze and interpret agricultural census data in relation to population census data.

5.1.5 Sharing Field Materials

Agricultural censuses are often conducted after the population census and can, therefore, make good use of the various population census field materials. Where an agricultural census is carried out by enumerating EAs, it can be based on the same EA boundaries as used in the population census. Furthermore it can make use of maps and other field materials used in the population census. In developing field procedures for the agricultural census, economies should make maximum use of all available field materials from the population census and elsewhere.

5.1.6 Using Population Census as Household Frame for Agricultural Census

Some economies carry out the household component of the agricultural census using the list of households from the population census as a frame. However, it can only be done if the agricultural census is carried out soon after the population census; otherwise, the list of households quickly becomes out-of-date and the list needs to be updated.

Some features of this approach are:

- The list of households from the population census provides a good frame for the agricultural census, even though it only identifies households, not agricultural holdings or even households with own-account agricultural production.

- The approach clearly distinguishes, in the agricultural census, between data for households and data for agricultural holdings. This is an important element in linking data between the two censuses (see paragraph 5.1.9).
- Using this approach, it is easy to widen the scope of the agricultural census to cover, for example, all rural households (see paragraph 7.1).
- Household data from the population census are also useful for constructing a sampling frame for a sample-based core agricultural census (see paragraphs 9.5).

5.1.7 Existing Agriculture-related Data in the Population Census

Three items normally included in the population census are of special interest for agricultural analysis:

- Main occupation (see paragraphs A.247– A.252). This item is collected for each economically active person. It can be used to provide tabulations of persons working in an agricultural occupation. This includes household members of agricultural holdings working in an agricultural occupation (on the household's holding or another holding), as well as persons working as employees in an agricultural occupation.
- Main industry. Industry is the activity of the establishment in which the person works in his/her main job. This item is collected for each economically active person, and can be used to provide tabulations of persons working in the agricultural industry. This includes household members of agricultural holdings working in the agricultural industry, as well as persons working as employees in the agricultural industry.
- Status in employment (see paragraphs A.241– A.246).

One weakness in agricultural employment data from the population census is that they are normally collected in respect of a person's main activity during a short reference period, such as a month. This may not identify all persons working in agriculture, because of the seasonality of agricultural activities.

5.1.8 Collecting Additional Agriculture-related Data in the Population Census

An economy may consider including additional agriculture-related items in its population census for two main reasons. First, the additional items can provide a wider range of agriculture-related data for the population census analysis. Second, the information can be used to help create the frame for the agricultural census.

Any additional agriculture-related data in the population census can also be useful for the sample design and selection for a sample-based agricultural census core module. It is recommended that highest priority be given to inclusion of additional agriculture-related items in the population census **either** at the household level **or** at the individual (person) level.

Household data

H1: Whether the Household is Engaged in Any Form of Own-Account Agricultural Production

- – Crop production
- – Livestock production

H2: Whether the Household is Engaged in Any Form of Own-Account Aquacultural Production

Person data

P1: Characteristics of All Agricultural Jobs During the Last Year

P2: Characteristics OF All Aquacultural Jobs During the Last Year

Item H1 is of interest for agricultural census frame purposes, as well as being useful for population census analysis. Two multiple-response categories, as shown, would indicate whether the household is engaged in own-account agricultural production in relation to crops or livestock or both crops and livestock.

Item H2 is a supplementary item on aquaculture that could be included in the population census if an aquacultural census is to be conducted in conjunction with the agricultural census. The main use of this information would be to provide a frame for the aquacultural census.

Item P1 covers all agricultural jobs of household members over a longer period, typically a year (see paragraph 5.1.6), to give a more complete picture of labor inputs provided by household members to the agricultural holding.

Item P2 is a supplementary item on aquaculture that could be included in the population census if an aquacultural census is to be conducted in conjunction with the agricultural census.

In some economies, the population census gives prominence to agriculture and it is possible to include a more detailed range of agriculture-related items. Other items that economies could consider for inclusion in the population census are:

- Total area of holding or area of agricultural land.
- Area harvested for each main crop.
- Number of each type of livestock.
- Time worked on own-account agriculture.

There are always heavy demands on the population census for the whole range of population, social and economic data, and it is often not possible to include additional agriculture-related items. There are constraints on the length of the questionnaire, the types of data collected, and the cost of data collection, as well as timing and operational factors. In developing their population censuses, economies need to determine priorities, taking into account the importance of agriculture to the economy.

5.1.9 Linking data from the agricultural and population censuses

One of the benefits of coordinating the agricultural and population censuses is that it opens up the possibility of linking data between the two collections. Linking data means that a particular household or agricultural holding in the agricultural census is matched to the same unit in the population census, so that data from the population census can be used in the

agricultural census tabulation and analysis. If data from the two censuses could be linked, it would no longer be necessary to collect these data again in the agricultural census. This could affect the following agricultural census items:

Core items

0003 Sex of agricultural holder
0004 Age of agricultural holder
0005 Household size

Supplementary items

0701 Ethnic group of household head or agricultural holder
0711 Sex of each household member
0712 Age of each household member
0713 Relationship to household head for each household member
0714 Marital status of each household member
0715 Educational attainment of each household member
0801 Activity status of each household member
0811 Status in employment for each economically active household member
0812 Occupation of main job for each economically active household member

Linking data is a complex statistical process, especially matching units between different statistical collections carried out at different times. Agricultural census data can only be linked to the population census through the household unit. The possibility of more than one holding in a household also complicates the linking of data.

5.1.10 Conducting the two censuses as a joint field operation

Some economies conduct the data collection for the population and agricultural censuses as a joint field operation. Normally, each census retains its separate identity and uses its own questionnaire, but field operations are synchronized so that the two data collections can be done at the same time by the same enumerators. Occasionally, the two censuses are merged into one.

Synchronizing the two census field operations in this way has several benefits:

- By doing the data collection for both censuses in a single field visit, the cost of data collection is reduced.
- It facilitates the use of the population census as a frame for the agricultural census, as it eliminates the problem of the population census household lists being out-of-date.
- It provides an immediate link between population and agricultural census household-level data. Demographic and economic activity status data required in the agricultural census can be obtained directly from the population census, rather than having to collect the data again as in a normal agricultural census, which results in further savings in data collection costs (see previous paragraph). The ability to link data also provides opportunities for wider analysis of both the population and agricultural censuses (see previous paragraph).
- Doing the data collection together makes it easy to apply standard concepts and definitions in the two censuses.

- There may be organizational benefits in having one enumeration team responsible for data collection in both censuses. Field training would be easier and a higher standard of enumeration work could be expected.

A problem in synchronizing the two censuses is that agricultural holdings in the non-household sector are not covered in the population census. These may need to be enumerated separately.

5.2 RELATIONSHIP WITH POPULATION HOUSING CENSUS

Housing censuses provide information on the characteristics of housing units, such as size, construction materials, and available services (UN, 1998). A housing census is normally conducted in association with a population census, and here, any link between the agricultural and population censuses would also provide a link between the agricultural census and the housing census. This would enable data from the housing census to be used for tabulation and analysis of the agricultural census. Housing conditions often reflect the economic status of a household, and therefore housing data can provide useful indicators of poverty. This can add a valuable new dimension to the agricultural census analysis.

5.3 RELATIONSHIP WITH ECONOMIC BUSINESS CENSUSES

The agricultural census is a component of the overall economic statistics system based on SNA and ISIC (see Annex A). Under SNA, all economic activities in an economy are divided into industries, such as agriculture, manufacturing, etc. In designing their economy-wide statistical systems, economies usually carry out a series of industry-specific economic censuses, or conduct regular economy-wide censuses covering all industries. Under this framework, the agricultural census measures the agricultural industry.

Economic censuses are normally carried out using the "establishment" as the statistical unit (see Annex I). The definition of the agricultural holding is compatible with the establishment concept. This opens up the possibility of integrating the agricultural census into the economic census program.

5.4 SUMMARY

It is not possible to give a unique set of recommendations to economies on relating the agricultural census with other censuses. Each economy’s circumstances are different, and the approach adopted will depend on the timing of the censuses, costs, data collection considerations, organizational arrangements for the censuses, and the existing coordination mechanisms. The opportunity for coordinating the various census activities should be actively explored at an early stage in the planning process, and be taken into consideration in developing economy-wide statistical plans. Economies should make the necessary administrative arrangements to ensure close collaboration between the census development teams and to ensure that all avenues for coordination are explored.

6. Combining the Census of Agriculture with the Aquaculture Census

WCA 2010 provides the option to carry out an aquacultural census in conjunction with the census of agriculture. This chapter discusses the main issues to be considered by economies in taking this approach. A proposal for an integrated census of agriculture and aquaculture is presented, based on the modular approach. The use of common concepts and definitions for the two censuses is discussed, and the potential for using a single core questionnaire for the collection of data for both censuses is highlighted.

6.1 INTRODUCTION

Aquaculture has become increasingly important in many economies, and there is a growing demand for data on the structure of the aquacultural production industry. Some economies collect aquacultural data as part of a general fisheries census, covering both capture fisheries and aquaculture. However, there is a strong interest in many economies to link aquaculture with agriculture by carrying out the agricultural and aquacultural censuses together.

In the past, the only aquacultural data included in the agricultural census program were a few items on aquacultural production carried out by agricultural holdings in association with agricultural production. This covered aquacultural activities integrated with agricultural production, or sharing the same inputs with agricultural production (see paragraph A.292). Aquacultural data collected in this way have three main limitations:

- Aquaculture carried out independently of agricultural production is not included.
- Only limited data on the basic characteristics of aquacultural activities are collected, such as area, type, source of water, and type of organism. Data such as machinery and labor relate specifically to inputs used for agricultural production, which exclude many aquacultural inputs. Also, area of holding may not fully reflect land used for aquaculture.
- The statistical unit for an agricultural census is the agricultural holding, whereas aquacultural data should relate to the economic unit of aquacultural production.

WCA 2010, like the previous programs, covers only agricultural production units, with aquacultural data limited to activities associated with agriculture. However, for the first time, WCA 2010 provides the option to conduct an aquacultural census at the same time as the agricultural census to cover all aquacultural production. Economies are strongly urged to take this option if aquaculture is an important economic activity.

It is not possible, in this document, to fully describe the concepts, definitions and methodology for aquacultural censuses. This chapter focuses on the main issues to be considered by economies in carrying out the two censuses together, with particular reference to the use of the modular approach. More information on the collection of aquacultural statistics may be found in *Guidelines on the Collection of Structural Aquaculture Statistics* (FAO, 1997b).

6.2 SCOPE OF AQUACULTURE CENSUS

According to ISIC (Rev. 3.1), agriculture and aquaculture are separate economic activities. Aquacultural production represents activities under ISIC Class 0502, whereas agricultural production is covered under the three ISIC Groups: 011, 012 and 013 (UN, 2004b). An aquacultural census therefore covers economic units in ISIC Class 0502, whereas an agricultural census covers economic units in ISIC Groups 011, 012 and 013. Statistically, the two censuses are separate, but operationally, they can often be combined into a single field enumeration system. Such a joint census is referred to as a census of agriculture and aquaculture.

Aquaculture is the farming of aquatic organisms such as fish, crustaceans, mollusks and plants, as opposed to other forms of aquatic exploitation such as capture fisheries. For more information on the definition of aquaculture, see paragraphs A.292– A.295. A clear distinction is made between aquaculture and capture fisheries. Data on capture fisheries are rarely collected along with an agricultural census because it is analogous to hunting and gathering, which is usually out of scope of the agricultural census.

6.3 STATISTICAL UNIT FOR AQUACULTURE CENSUS

The statistical unit for the aquacultural census is the aquacultural holding, defined in a similar way to an agricultural holding as follows:

- An aquacultural holding is an economic unit of aquacultural production under single management, comprising all aquaculture facilities without regard to title, legal form, or size.
- Single management may be exercised by an individual or household, jointly by two or more individuals or households, by a clan or tribe, or by a juridical person such as a corporation, cooperative or government agency.
- The aquacultural holding's aquaculture facilities are located in one or more separate areas or in one or more territorial or administrative divisions, providing the facilities share the same production means, such as labor, buildings and machinery.

Agricultural holdings and aquacultural holdings are distinct establishment units operating in different industries under the SNA/ISIC framework (see Annex I). However, they may be closely related in that they may be part of the same enterprise; for example, a household may contain both an agricultural holding and an aquacultural holding. An agricultural holding and an aquacultural holding may also share the same inputs such as land, machinery and labor; for example, as in rice-cum-fish culture.

An agricultural holding may have some own-account aquacultural production as a secondary activity. However, this should be small-scale compared with the agricultural holding’s principal agricultural production activity. If aquaculture is as important, or nearly as

important, as the agricultural production activity, two units should be formed: an agricultural holding and an aquacultural holding. The same situation applies to an aquacultural holding also engaged in own-account agricultural production activities.

6.4 BASIC APPROACH FOR AQUACULTURE CENSUS

It is recommended that aquacultural censuses use the same modular approach as for agricultural censuses, with the core module providing a limited set of key data on the structure of aquacultural holdings and a sample-based supplementary module providing more detailed structural data. This approach offers a cost-effective way of producing a wide range of aquacultural data.

The agricultural census core items relate to basic structural data, such as household size and land use, and these should also be included in the aquacultural census. It is recommended that one additional aquaculture-related item – area of aquaculture by type of site – be included in the core aquacultural census module (see paragraph 6.5.1). The use of a common set of core items for the agricultural and aquacultural censuses may make it possible to conduct the core modules of the two censuses using the same questionnaire.

The sample-based supplementary module should include the same aquacultural items as under Theme 10 of the agricultural census (see paragraphs A.297– A.311). A typical aquacultural module would also items from other themes such as crops and economic activity of household members.

6.5 METHODOLOGY FOR A CENSUS OF AGRICULTURE AND AQUACULTURE

This section presents a broad outline of the methodology for the joint census of agriculture and aquaculture and discusses the implications for the item definitions of combining the two census operations.

6.5.1 Core Module

The frame for the core modules of the census of agriculture and aquaculture can be created in various ways:

- Use a frame of households from the population census to provide the basis for identifying agricultural holdings and aquacultural holdings in the household sector in the census of agriculture and aquaculture.
- Include additional questions in the population census to identify households engaged in own-account agricultural production and/or own-account aquacultural production.
- Develop a frame of agricultural and/or aquacultural holdings from administrative sources, such as business registrations. This may be applicable for the non-household sector.

Usually, a combination of frames is used for a census of agriculture and aquaculture. The methodology used for the joint census will depend on the type of frame. If the frame for the household sector is based on households from the population census, the core modules would be conducted as follows:

- Construct the basic frame of households for the census of agriculture and aquaculture from the list of households enumerated in the population census (if the census of agriculture and aquaculture is carried out soon after the population census) or updated lists of households in population census EAs (if the census of agriculture and aquaculture is carried out some time after the population census).
- In the census of agriculture and aquaculture, ask each household some screening questions to identify households that are involved in crop, livestock or aquacultural production activities. Use this information to identify all agricultural holdings and all aquacultural holdings.
- Enumerate all agricultural holdings and aquacultural holdings to collect the core data for the census of agriculture and aquaculture.

An important element in integrating the agricultural and aquacultural censuses is the use of common items, concepts and definitions for the two censuses. Minor changes are needed to make some items applicable to both agricultural holdings and aquacultural holdings. For example, the “agricultural holder” in Items 0003 and 0004 could be renamed the “holder”, to describe the main decision-maker for either an agricultural holding or an aquacultural holding. Also, Item 0006 (main purpose of production) would need to be amended for the aquacultural census to cover income from aquacultural production.

More substantial changes may be needed for Item 0007 (area of holding according to land use types) and Item 0008 (area of holding). Area of holding in an agricultural census excludes bodies of water used for aquaculture but not owned by the holding, such as seawater (see paragraph A.44). This is of special interest in an aquacultural census, and the definition of area of holding should be modified for a census of agriculture and aquaculture. For the purposes of measuring area of holding in the census of agriculture and aquaculture, the area of a body of water should be defined as the surface area of the water body. Also, bodies of water should be separately identified under “Other land” in the land use classification.

It is recommended that one additional aquaculture-related item be included in the core module of the aquacultural census. This item is the same as supplementary Item 1001 (see paragraphs A.297– A.300).

0017 Area of Aquaculture by Type of Site (for the holding)

- Land-based
- □Arable land
- Non-arable land
- Inland open water
- Coastal and sea water

6.5.2 Supplementary Modules

Census supplementary modules for the census of agriculture and aquaculture should be based on frames provided by the core modules. The supplementary modules could be surveys of agricultural holdings, aquacultural holdings, or both agricultural holdings and aquacultural holdings. For example, an aquacultural module would be based on a frame of aquacultural holdings, whereas a household food security module might cover both agricultural holdings and aquacultural holdings.

The supplementary items listed in Chapter 4 should provide the basis for designing the supplementary modules for the census of agriculture and aquaculture. Aquacultural items should be the same as in a standard agricultural census, except for Item 1001, which is recommended for inclusion in the core module. For other supplementary items, the concepts and definitions depend on the scope of the supplementary module. For a module that covers specific agricultural holdings only, the concepts and definitions given in Annex I would be applicable. However, for a module covering aquacultural holdings, some changes would be needed:

- Theme 01: Land. If the definition of area of holding is changed to include bodies of water, additional aquacultural parcels would need to be defined. Parcels could consist of bodies of water. Special procedures would be needed for Item 0101 (location of parcel) where a parcel is not located in an administrative division, but in the sea. Item 0105 (presence of shifting cultivation) and Item 0106 (years since land cleared) would not be applicable to parcels consisting of bodies of water.
- Theme 02: Irrigation and water management. In a standard agricultural census, the concept of irrigation refers to providing land with water to improve crop production. This concept may be widened to also include the provision of water for aquaculture.
- Theme 05: Agricultural practices. As it stands, this category of items refers only to practices used for crop and livestock production. This would need to be expanded to cover aquaculture. Item 0505 should include machinery and equipment used for aquacultural production. Some additional practices specific to aquaculture may also be included.
- Theme 06: Agricultural services. These items should also cover services for aquaculture. Items 0601–0604, relating to the use of credit facilities, should include credit for aquacultural purposes. Items 0605-0606, relating to sources of information and extension services, would also need to cover services for aquaculture.
- Theme 07: Farm labor. Item 0814, relating to work on the holding, should include work in connection with aquaculture. Items 0821 and 0822, relating to employees on the holding, should include labor used for aquacultural production. Item 0823, relating to contract work on the holding, should also include work for aquacultural production.

The need for data specific to agricultural holdings or to aquacultural holdings should also be considered in developing census supplementary modules. For example, in an agricultural or aquacultural practices module, separate data may be needed on machinery used for: (i) only agriculture; (ii) only aquaculture; and (iii) both agriculture and aquaculture. Questionnaires need to be carefully designed to ensure that those needs can be met.

The sub-holding and sub-holder concepts may also need to be reviewed for a census of agriculture and aquaculture. A sub-holding is normally defined on the basis of an own-account agricultural production activity managed by a particular person (see paragraph 3.44). This may need to be widened to cover both agricultural and aquacultural activities.

7. Collecting Data from Nonagricultural Producers' Households

Chapters 1–6 focus on traditional agricultural censuses, covering economic units (agricultural holdings) engaged in crop and livestock production activities. All APEC economies might want to consider obtaining additional data for other households, such as for households living in rural areas or households whose members are working in the agricultural industry especially for food security purposes. This chapter discusses issues to be considered for collection of such additional data from their agricultural censuses. The use of the population census or existing surveys as a possible source for these data is also examined.

7.1 INTRODUCTION

Agricultural censuses, as presented in earlier chapters, aim to measure the structure of crop and livestock production activities carried out by agricultural holdings. Some economies might like to use the agricultural census to also collect additional data on households that are not agricultural holdings. This is especially true to obtain a better understanding of the rural household structure for creation of a food security database.

Often, in an agricultural census, it is necessary to interview and screen each household to identify agricultural holdings, before going on to collect the required agriculture-related data from each holding. If the census design includes screening of all households, it can be cheap and easy to collect additional data for all households. Some economies might be interested in providing data specifically for households that are involved in agriculture in some way, such as households living in rural areas or households whose members are working in agriculture. The main interest in these households would center on socio-economic data, such as demographic and economic activity data.

7.2 USE OF A POPULATION CENSUS OR SURVEY TO MEET ADDITIONAL DATA NEEDS

A population census provides a wide range of data on the characteristics of the population, such as sex, age, and activity status, status in employment, occupation and industry. Sometimes, income data are also provided. The target group of interest for the additional data can also usually be identified through a screening process. It is recommended that consideration first be given to meeting additional data needs of this type through the population census, rather than the agricultural census. As noted in Chapter 5, the agricultural census development team should work closely with the population census development team

to coordinate the two activities and find the best way to satisfy data needs. Thus, data not normally covered in a population census, such as household food security or household income, may also be needed.

7.3 SCOPE OF A WIDENED AGRICULTURAL CENSUS

The scope of a wider agricultural census depends on the data requirements. Some economies may wish to cover all households. Some economies may wish to carry out a census of rural households. Rural households are defined in terms of households living in areas designated as rural areas, usually based on the population census. There are no standard criteria for classifying areas as urban or rural. Often, it is based on population density; for example, a rural community could be defined as one with population density less than 150 inhabitants/square kilometer. Note that a census of rural households, on its own, would not cover all agricultural holdings; some households living in urban areas have crop and livestock production activities.

Another type of wider agricultural census is one that covers all households containing at least one member employed in an agricultural occupation. This would include households with persons working on their own holding, as well as households with persons working as employees in agricultural jobs. Note that, in widening the agricultural census in this way, three types of statistical units would be covered: (i) agricultural holdings in the household sector; (ii) agricultural holdings in the non-household sector; and (iii) non-production households.

7.4 ANALYZING HOUSEHOLD DATA FOR AGRICULTURAL HOLDINGS AND NON-PRODUCTION HOUSEHOLDS

To analyze a wider agricultural census, data from non-production households need to be combined with data from agricultural holdings in the household sector. To do this, a common statistical unit – the household – is needed.

The definition of an agricultural holding distinguishes between the economic unit of agricultural production and the household (see paragraph 2.5). Many economies define the two units to be equivalent, which simplifies the analysis of a wider agricultural census. If the holding and household units are different, the two units need to be clearly distinguished in the data collection and analysis.

In terms of household data, a wider agricultural census includes two types of households: (i) households with own-account agricultural production (that is, households associated with holdings in the household sector); and (ii) non-production households.

7.5 METHODOLOGY AND ITEMS FOR A WIDER AGRICULTURAL CENSUS

A wider agricultural census should be carried out within the same modular framework as for a normal agricultural census.

7.5.1 Core module

Some core agricultural census items identified in Chapter 3 could also be applicable to non-production households; in particular, Item 0005: Household size; Item 0014: Presence of

aquaculture; Item 0015: Presence of forest and other wooded land; and Item 0016: Other economic production activities. Other household items could be included to meet data requirements.

7.5.2 Supplementary Modules

Census supplementary modules for a wider agricultural census would be carried out as per a normal agricultural census. The supplementary modules could be of two types. First, there are the normal census supplementary modules based on agricultural holding frames. Items should be chosen from the list of items in Chapter 3. Concepts and definitions in Annex I apply.

Second, there are modules based on a frame of non-production households and households with own-account agricultural production. These could cover supplementary themes shown in Chapter 3; in particular, Theme 07 (demographic and social characteristics); Theme 08 (farm labor); Theme 09 (household food security); Theme 10 (aquaculture); and Theme 11 (forestry). Modules on household food security module or farm labor could be particularly useful, given the wider coverage of households.

7.6 FRAME FOR A WIDER AGRICULTURAL CENSUS

Various frame options are available. A frame of households or EAs from the population census is commonly used. If necessary, screening questions are asked in the agricultural census to identify the specific non-production households to be covered by the agricultural census. Depending on the content of the population census, it may be possible to construct a frame of agricultural holdings and non-production households directly from the population census.

8. Program of Agricultural Surveys

WCA 2010 envisages the census of agriculture being the central component of the system of integrated agricultural censuses and surveys. Previous chapters have focused on the core and supplementary modules of the census of agriculture. This chapter presents a broad overview of the program of agricultural surveys to be developed based on the census of agriculture. Some possible topics for the program of agricultural surveys are identified and a brief description of the content of each survey is provided.

8.1 INTRODUCTION

Throughout this publication, emphasis has been given to the census of agriculture as a part of the system of integrated agricultural censuses and surveys. The census of agriculture provides structural data on agriculture, with the key data collected in the core module, and more detailed items collected in the sample-based supplementary module(s). Under the integrated system, a program of agricultural surveys should also be carried out, based on the census of agriculture, to provide current operational and performance data required to complement the structural data from the census of agriculture. Previous chapters have focused on the census of agriculture; in this chapter, the program of agricultural surveys is examined.

The program of agricultural surveys outlined in this chapter is wide-ranging, and includes periodic agricultural production surveys, as well as in-depth surveys such as cost of production and time use. It is not possible in this handbook to give a detailed description of all possible agricultural surveys. Instead, the most important types of agricultural surveys are highlighted.

The intention is not to recommend the surveys each economy should carry out. Each economy has its own way of organizing the economy-wide survey program for agricultural and other statistics. Most economies conduct periodic agricultural production surveys, but other agricultural surveys are conducted according to domestic priorities and data requirements, taking into consideration cost and other constraints. Economies are encouraged to plan the program of agricultural surveys prior to the agricultural census, to ensure that the census is integrated into the agricultural statistics system and that the census meets the needs of the program of agricultural surveys.

8.2 BETWEEN-CENSUS STRUCTURAL AGRICULTURAL SURVEYS

Agricultural censuses are normally carried out every ten years, covering those aspects of agriculture that change slowly over time: the so-called “structural” data. Economies

undergoing rapid agricultural development may find that structural changes happen quickly, and structural data may be needed more frequently than every ten years.

Some economies may wish to conduct an agricultural census every five years, based on the modular approach described in this publication. Sometimes, a “mini-census” is conducted in the middle of the decennial between-census periods to provide certain key structural data. A modular approach could be used: for example, if cropping patterns were changing rapidly, the core module of the mini-census could focus on land use and crops, with sample-based supplementary modules on crops and agricultural practices undertaken to provide more detailed data.

Usually, economies do not have enough resources for a five-yearly agricultural census, and need to collect additional structural data between censuses through sample surveys. The type of data collected in a between-census structural survey depends on the nature of agricultural development in the economy. For example, if the livestock industry was developing rapidly, the between-census structural survey could repeat the census supplementary module on livestock. Elements from other modules related to livestock, such as household food security and farm labor, could also be included. Sometimes, the main interest in a between-census structural survey is on changes for particular crop or livestock types, and the between-census survey could focus on those.

8.3 CROPS

The agricultural census provides data on the presence of each temporary and permanent crop (core module), and the area and production of each crop, use of fertilizer, and source and type of seed inputs (supplementary module). A variety of crop surveys are usually needed to complement these data.

The key requirement is for annual or seasonal data on the production of major crops. This could require a single crop production survey or, more commonly, a series of surveys. For example, an economy may need to carry out a semi-annual rice production survey, as well as annual cassava and coffee production surveys, with each survey timed to coincide with the crop harvest. A particular crop production survey could have several elements: for example, an interview with producers to collect information such as area planted, varieties used and inputs, and a crop-cutting component to estimate the yield based on sample plots.

Crop production surveys may be a part of a comprehensive crop forecasting system. This could involve, for example: (i) a survey of planting intentions conducted just before planting; (ii) a survey of crop plantings taken just after planting is finished; (iii) a survey of crop conditions carried out sometime before the harvest, and (iv) a crop production survey undertaken after the harvest.

Other types of crop surveys, based on agricultural holdings, may be required from time to time:

- Survey of post-harvest losses. A survey of post-harvest losses for rice producers, for example, measures the losses during harvesting, on-farm processing, transportation and storage. Such surveys are important to measure the effect of post-harvest losses on food supplies.

- Survey of farm food stocks. This looks at the quantity of, for example, maize held in stock by maize producers, and is important for assessing household food security in economies where farmers produce mainly for their own consumption.
- Survey of crop marketing. A survey of wheat producers, for example, could be conducted to understand how farmers market their surpluses.
- Special survey of a specific crop. An in-depth survey of, for example, fruit growers could highlight the problems faced in further developing the fruit production industry.

8.4 LIVESTOCK

In the agricultural census, the core module provides data on the number of animals by livestock type, while the livestock supplementary module includes data on the structure of livestock herds (age, sex and purpose), livestock population dynamics (births, deaths, etc.), and types of feed.

The key requirement for additional livestock data is for periodic livestock production surveys. Usually, a series of specific surveys is needed. For example, quarterly surveys of holdings with cattle may provide data on cow milk production, while annual surveys of holdings with sheep may provide data on wool production. Often, data from these surveys are supplemented by information from other sources – such as livestock marketing boards, or surveys of abattoirs, meat packing plants, butchers or dairies – to provide a comprehensive picture of livestock production.

Regular surveys may be needed for feed statistics to measure the quantity and composition of feed for different livestock types, and the seasonality of feed availability. Surveys can also be used to estimate the production of fodder crops, often using crop cutting experiments to measure nutritive values. Data on stocking rates are also often collected as a way of assessing fodder utilization.

Other types of in-depth surveys of livestock include: surveys on the structure of livestock herds, especially specific breeds of animals; and surveys of the value of sales for each type of livestock product.

8.5 AQUACULTURE

In the agricultural census, data are limited to aquacultural activities carried out in association with agriculture. If aquaculture is important in an economy, an aquacultural census should be undertaken in conjunction with the agricultural census, to provide structural data on the type of production facility, type of water, sources of water, type of organism, and aquacultural machinery (see Chapter 6). This can provide the basis for further aquacultural surveys.

Periodic surveys of aquacultural producers may be needed to provide aquacultural production data. An in-depth aquacultural survey could also be conducted to further explore the topics covered in the aquacultural census. Items collected could include:

- Specific species of aquatic organisms cultivated;
- Identification of pens, cages, and floating rafts, and measurement of the number of units, area and depth;

- more information on tanks and raceways, including the number of units and the volume of water;
- seed and juvenile production of the aquatic organisms;
- type and source of fish-feeds, use of fertilizers, and use of biocides;
- cost of production of aquacultural products;
- more information on the integration between agriculture and aquaculture, such as sharing inputs and the use of agricultural products as inputs to aquaculture.

8.6 FARM MANAGEMENT AND COST OF PRODUCTION

Farm management surveys provide detailed data on all aspects of decision-making on holdings. Data related to investments, assets, organizational structure and allocation of resources are usually collected. Farm management surveys are often carried out in conjunction with cost of production surveys.

Cost of production surveys measure the cost structures of specific agricultural activities, and provide key data for compiling the production accounts for agriculture and for assessing the competitiveness of particular agricultural industries. Cost of production surveys are usually specific to particular agricultural activities, such as tobacco production or goat meat production. Costs of production include operational costs – such as inputs, fuel, transport, interest, taxes and labor – as well as fixed costs such as land and equipment.

8.7 TIME USE

Time use surveys provide information on how people spend their time. Time use data show the time spent on different types of activities, such as working, education, home-making and recreation. Time use surveys have many uses, including assessing paid and unpaid work and analyzing social issues. Time use surveys normally have a full economy-wide coverage, but a time use survey specific to agricultural holdings could be useful in economies where it is difficult to measure the contribution of household members to work on the holding. A time use survey could collect data on the time spent by each household member on activities such as: land preparation; planting, maintaining or harvesting crops; post-harvest crop activities; feeding animals; and providing support services to agricultural workers. This would be especially useful for measuring the role of women in agriculture.

9. Sampling Frames for Agricultural Censuses and Surveys

One of the important aims of the census of agriculture is to provide a sampling frame for the agricultural survey program. This chapter explains what a sampling frame is, and how a census can be used to create a sampling frame. It also discusses the use of population and agricultural censuses to create sampling frames for the agricultural census supplementary modules and the program of agricultural surveys. Both single-stage and multi-stage sampling frames are considered, and the problems of keeping sampling frames up-to-date are highlighted.

9.1 WHAT IS A SAMPLING FRAME?

In a census, each unit (such as person, household or holding) is enumerated, whereas in a sample survey, only a sample of units is enumerated and information provided by the sample is used to make estimates relating to all units. In an agricultural production sample survey, for example, a sample of agricultural holdings is enumerated, and information from the sample holdings is used to make estimates of total agricultural production.

In a sample survey, the sample of units to be enumerated must be selected using strict statistical procedures. A method known as random sampling is used. Random sampling is the process of selecting units for inclusion in the sample in such a way that each unit has a known, though not necessarily the same, chance (or probability) of selection. The simplest type of random sample is one selected by “lottery”, where all units have the same chance of selection in the sample; for example, in an agricultural survey, each agricultural holding would have the same chance of selection. Usually, sampling schemes are more complex than this, with units having differing probabilities of selection in the sample. In an agricultural survey, for example, large holdings may be given more chance of selection than small holdings; some very large holdings may even be completely enumerated.

To select a random sample for a sample survey, one needs, first, to clearly define which units are within the scope of the survey. Some specific surveys and the in-scope units are:

- Economy-wide agricultural survey: all agricultural holdings in an economy.
- Agricultural survey in Province A: all agricultural holdings in Province A.
- Economy-wide rice production survey: all rice producers in the economy.
- Economy-wide aquacultural production survey: all aquacultural producers in the economy.

Having determined the scope of the survey, a means of identifying all the in-scope units is needed, so that each unit can be given the required chance of selection in the sample. This is called a sampling frame. A sampling frame could be a list of units (such as households or holdings), areas (such as EAs), or any other materials (such as maps), and may also include information about each unit, such as their size, to help with the sample selection or survey estimation (FAO, 1989, pp 32–41; UN, 1986).

The best type of sampling frame is a list of all units within the scope of the survey. For example, for an economy-wide agricultural survey, the sampling frame would be a list of all agricultural holdings in the economy. Here, the sample of holdings would be selected directly from this list, by giving each holding on the list the appropriate chance of selection in the sample. The sampling frame must provide a complete and up-to-date list of holdings, without omissions or duplications, and without including any units other than holdings.

Often, updating lists of households or agricultural holdings from a population or agricultural census for sampling frame purposes is too difficult or expensive. Instead, a sampling technique known as multi-stage sampling is used. In multi-stage sampling, random sampling is carried out in stages, as opposed to single-stage sampling where the sample is selected directly from lists of households or holdings. Thus, for an agricultural survey, a sample of EAs could be selected first, and then a sample of agricultural holdings selected in each sample EA. In multi-stage sampling, sampling frames are needed for each stage of sampling: in the example above, a list of all EAs in the economy to select the sample of EAs, and lists of agricultural holdings in each sample EA to select the sample of holdings.

Multi-stage sampling is widely used for agricultural surveys, especially for the household sector. Its main advantage is that it is cheaper and easier to create lists of holdings just in the selected areas, rather than for the whole economy. Data collection is also cheaper because the sample holdings are concentrated in the selected areas, rather being spread around the whole economy. However, sampling errors are higher because of the “clustering” of sample in selected areas. Sometimes, multi-stage sampling is used in conjunction with single-stage sampling (see paragraph 9.3 below).

Note that, for an agricultural survey, it is not necessary to have any information about agriculture on the sampling frame. A sampling frame of households, rather than agricultural holdings, is often used for the household sector as part of a multi-stage sampling scheme. Often the population census, rather than the agricultural census, is used for this purpose (see paragraph 9.4 below).

Another type of sampling frame often used in agricultural surveys is an area sample frame. In area sampling, the unit being sampled is a physical piece of land, called a segment. A sample of segments is selected and data are collected in respect of the agricultural activities of each sample segment. Here, the sampling frame consists of all the segments making up the whole area within the scope of the survey. For example, for an agricultural survey in Province A, the sampling frame could be a map of Province A divided into clearly defined segments.

A variety of sampling techniques – such as stratification, systematic sampling, and probability proportional to size sampling – can be used to improve the efficiency of the sample design. Techniques such as ratio and regression estimation may also be used to improve the reliability of survey data. A description of these techniques is outside the scope of this handbook.

9.2 Sampling Frames for Census Supplementary Modules

In the agricultural census, the supplementary modules are undertaken at the same time as, or soon after, the core module. Thus, the core module provides up-to-date lists of holdings for use as sampling frames for the supplementary modules. Examples of supplementary modules and the relevant sampling frames from the core module are:

- Crop supplementary module: list of agricultural holdings with temporary crops in Item 0011 or permanent crops in Item 0012.
- Livestock supplementary module: list of agricultural holdings with livestock in Item 0013.
- Agricultural practices module: list of all agricultural holdings.

One way to carry out a supplementary module based on the core census module is to use single-stage sampling. For example, a livestock module could be carried out as follows:

- Conduct the core census module by enumerating all holdings.
- During the core census enumeration, identify all holdings with livestock, to be used as a sampling frame for the livestock module.
- Select a sample of holdings with livestock based on this sampling frame, in accordance with the required sampling scheme, and enumerate those holdings for the livestock module.

This method may be difficult to implement for a supplementary module carried out at the same time as the core module, because enumerators would need to do the sample selection in the field. A multi-stage sampling approach is more commonly used as follows:

- Divide the economy into EAs for the purpose of organizing the enumeration of the core census module.
- Prior to the census enumeration, select a sample of EAs for the livestock module.
- Conduct the core census module by enumerating all holdings in all EAs.
- During the core census enumeration, identify all holdings with livestock in the sample EAs. Special holdings with livestock, such as large units, would also be identified in the non-sample EAs.
- For the livestock module, enumerate all holdings with livestock in the sample EAs and all special holdings with livestock in the non-sample EAs.

The advantage of the multi-stage approach is that the sample selection of EAs can be done by technical staff prior to the fieldwork, rather than requiring each enumerator to do the sample selection. This makes the census field operations easier. A convenient way to organize the census enumeration would be to assign the best enumerators to the sample EAs, to interview each holding for the core module, and, if the holding is within the scope of the supplementary module, ask further questions for the supplementary module. All other enumerators would be assigned to the non-sample EAs to collect core data only. Senior field staff could enumerate the special holdings.

9.3 SAMPLING FRAMES FOR THE PROGRAM OF AGRICULTURAL SURVEYS

Some examples of agricultural surveys and the applicable sampling frames from the core census module are shown below:

- Rice production survey: list of holdings growing rice in Item 0011.
- Pig production survey: list of holdings with pigs in Item 0013.
- Gender survey: list of holdings with sex of agricultural holder as female in Item 0003.
- Survey of young farmers: list of holdings with age of holder less than 25 years in Item 0004.

From a sampling point of view, an agricultural survey is like a census supplementary module, except that it is not carried out as part of the agricultural census, but some time later. This has implications for the sampling methodology. For example, a list of holdings with pigs from the core census module would not be accurate for a pig production survey conducted some years after the agricultural census. Even a gap of several months could result in serious shortcomings in the sampling frame.

Where a list of in-scope units from the core census module is deemed to be acceptable as a sampling frame for an agricultural survey, the frame can be established in a similar way to that for a census supplementary module, using either single-stage sampling (see paragraph 9.2 above) or multi-stage sampling (see paragraph 9.2 above). The single-stage approach is usually better suited to an agricultural survey than a census supplementary survey, because the survey is carried out some time after the agricultural census, and sample selection can be done by technical staff prior to the survey, rather than by the enumerators as in a census supplementary module. However, the multi-stage approach is often still preferred because the "clustering" of sample reduces data collection costs (see paragraph 9.1).

Where a list of in-scope units from the core census module is not accurate enough to be used as a sampling frame for the agricultural survey, a different sampling approach is needed. Some alternatives are discussed below.

9.3.1 Update the Sampling Frame of In-Scope Units: Single-Stage Sampling

The best approach is to maintain an up-to-date list of agricultural holdings to provide a sampling frame for agricultural surveys undertaken at any time. Some economies maintain a register of holdings, containing basic information about each holding such as main agricultural activity and size. If specific crop production surveys are required, information about specific crops grown would also need to be provided on the register.

Keeping registers of holdings up-to-date is difficult and expensive. Often, it can be done by making use of information from government regulatory agencies, producers' associations, telephone directories, or other administrative sources. Sometimes, the results of surveys and other statistical activities can be used to update the register. Many economies are unable to make available the necessary resources to do this work.

9.3.2 Multistage Sampling

Even if the list of holdings from the agricultural census core module is not good enough to directly select the sample for the agricultural survey, the core census data can still be useful

for the sample design and fieldwork in a multi-stage sample design. A common sampling method, using a wheat production survey as an example, is given below:

- Select a sample of agricultural census EAs, using sampling techniques such as stratification and probability proportional to size sampling, based on wheat data from the core census module. A typical design would sample important wheat growing areas more heavily than other areas.
- Prepare a list of wheat producers in each sample EA, by updating lists of units available from the agricultural census core module.
- Select a sample of wheat producers in each sample EA, and enumerate those units for the survey.

Multi-stage surveys may not be efficient for agricultural surveys because they do not allow large holdings to be sampled more heavily than small holdings. This is of particular concern where there are a few dominant holdings, especially in the non-household sector. For this reason, a combination of single- and multi-stage sampling is preferred for agricultural surveys (see paragraphs below).

Another problem with multi-stage surveys of this type is that there can be changes in the administrative structure on which the EAs are based. Low-level administrative units such as communes and villages may change frequently, and this makes it difficult for enumerators to identify EAs in a survey conducted some years after the agricultural census. Special field procedures are needed to deal with this problem.

9.3.3 Combination of Single- and Multistage Sampling

Another approach is to use a combination of single- and multi-stage sampling. One way to do this is to create an up-to-date list of holdings for certain types of holdings only, with single-stage sampling used for those units and multi-stage sampling used for all other units.

For agricultural surveys, single-stage sampling is often used for the non-household sector or for large or otherwise important units, using a sampling frame of agricultural holdings obtained from the agricultural census and updated using business registration records. Multi-stage sampling is then used to cover the household sector.

Another way is to use a list of holdings from the agricultural census as a sampling frame for those units present at the time of the census, with a small supplementary multi-stage sample used for other units.

9.4 SPECIAL SAMPLING FRAME SITUATIONS FOR AGRICULTURAL SURVEYS

9.4.1 Periodic Surveys

Some agricultural surveys are conducted on a regular basis; for example, a cassava production survey may be needed once a year to measure annual cassava production. For such surveys, the sampling frame must be updated each time the survey is run. Where multi-stage sampling is used, the list of units – for example, cassava production holdings – in each sample area must be updated for each round of the survey.

9.4.2 Longitudinal Surveys

A longitudinal survey is a special type of periodic survey aimed at studying changes in the behavior of a particular group over time; for example, to assess how a group of maize farmers change their farming practices over time. Unlike normal ongoing surveys, longitudinal surveys are not designed to provide aggregated data, such as domestic maize production. In a longitudinal survey, the sample of units is selected at the start of the study and those units are followed up in each round of the survey. Longitudinal surveys only need a sampling frame at the beginning of the study. An agricultural census provides an ideal frame for a longitudinal study beginning soon after the census.

9.4.3 Census Supplementary Modules as Sampling Frames for Agriculture Surveys

Usually, the sampling frame for an agricultural survey is obtained from the core module of the agricultural census. However, a supplementary module can also provide a good sampling frame, as shown in the following example for a survey of organic farmers.

- Conduct the agricultural census core module as normal.
- As part of the agricultural census, carry out a census supplementary module on agricultural practices, based on the sampling frame of agricultural holdings from the core module.
- Form a list of organic farmers from the agricultural practices module, and use this as a frame to select the sample of organic farmers for the survey of organic farming. This frame would need to be updated if the survey is conducted sometime after the agricultural census.

9.4.4 Use of Population Census as a Household Sampling Frame for Agriculture Surveys

As noted in paragraph 9.1, a household sampling frame from the population census can be used to select the sample for the household sector of an agricultural survey. Non-household units would be covered by a separate sampling frame. A common household sampling method is:

- Select a sample of population census EAs.
- In each sample EA, form a list of population census households, updated as necessary if the survey is conducted sometime after the population census. Select a sample of households in each sample EA, based on these household lists.
- Interview each sample household to ask screening questions to find out if the household contains an agricultural holding within the scope of the survey.
- Enumerate each holding identified in this way to collect data for the survey.

A population census sometimes provides a better sampling frame than an agricultural census, because it covers all households in the economy, rather than just agricultural holdings. It can therefore be used as a sampling frame for agricultural surveys with a wider coverage than agricultural holdings. For example, a household food security survey usually covers all rural households or even all households in the economy. Also, a farm labor survey should cover not only agricultural holdings, but also other households with members working in agriculture.

Sampling error issues need to be considered when using the population census as a frame for agricultural surveys. The smaller the proportion of households covered by the survey, the higher will be the sampling errors. Thus, the household sampling approach might be suitable for a chicken production survey, but would be less satisfactory for a goose production survey.

9.4.5 Master Sampling Frames

A master sampling frame is a general purpose sampling frame created from a census, for use in selecting samples for different surveys or different rounds of a periodic survey. The frame is usually maintained by the national statistical office, and is updated on an ongoing basis so that it is available for any survey carried out at any time.

A master sampling frame has several benefits. It is quick and easy to conduct surveys of any kind, because a ready-made frame is already available. The cost of preparing sampling materials and selecting samples is also reduced. Master sampling frames also make it easier to relate data from different surveys and to control the reporting burden on survey respondents.

Master sampling frames suitable for agricultural surveys may be available from either the population census or the agricultural census.

- Population census. The population census master sampling frame is a database of small geographical units, such as villages or EAs, containing key data about each unit, such as the population and the number of households. This can be used to select samples for any type of household survey, including agricultural surveys (see paragraph 9.4.4 above). A supplementary frame may be needed for non-household holdings and any other large holdings.
- Agricultural census. Agricultural census master sampling frames are of two types. One type is similar to a population census master sampling frame in that it is a database of small geographical units, such as villages or EAs, containing key agricultural data about each unit, such as the area of major crops and the number of livestock. Another type of agricultural census master sampling frame is a database of agricultural holdings, created and maintained following an agricultural census, containing key agricultural data about each holding, such as the crops grown and the livestock raised. Often, the master sampling frame is a combination of the two frame types, with a database of all important agricultural holdings complementing the EA frame. A master sampling frame from an agricultural census can be used for any type of survey of agricultural holdings.

A similar form of sampling frame is a register of businesses, containing information such as management structure, industry, employment, and turnover for each business unit. This can be used as a sampling frame for any economic survey. Usually, such frames include agriculture, sometimes for the non-household sector only, and can also be used for agricultural surveys.

9.5 SAMPLING FRAMES FOR A SAMPLE-BASED AGRICULTURAL CENSUS CORE MODULE

So far, this chapter has looked at sampling frames from the agricultural census in situations where the core census module is based on a complete enumeration of agricultural holdings.

This section considers sampling frame issues where the core module is carried out on a sample basis.

In a sample-based core census module, a sampling frame is needed for the core module itself. For the household sector, this is normally based on the population census. The sampling methods are similar to those for any other agricultural survey. Sometimes, the population census provides information on households engaged in own-account agricultural production for use in the sample design and selection for the core module. For the non-household sector, a frame from administrative sources is often used.

A sample-based core census module can still provide a sampling frame for the census supplementary modules and the program of agricultural surveys, even though the core module itself is only a sample of agricultural holdings. This can be done by sub-sampling core module holdings. This is illustrated in Table1, using an aquacultural supplementary module as an example.

Table 1
Household Sampling Frames from Complete and Sample Enumeration Core Modules

Step	Complete enumeration core module	Sample core module
1. Core census module frame	List all households by EA from the population census.	List all households by EA from the population census.
2. Core census module enumeration	Enumerate all households in all EAs to identify agricultural holdings; do core census module for all agricultural holdings.	Select a sample of EAs and then a sample of households in selected EAs; enumerate sample households to identify agricultural holdings; do core census module for sample holdings.
3. Frame for aquacultural Supplementary module	List all holdings in the economy with aquaculture, based on the core census module.	List holdings with aquaculture as enumerated in the sample core census module.
4. Sample for aquacultural module	Select a sample of holdings with aquaculture from the aquacultural frame.	Select a sample of holdings with aquaculture from the aquacultural frame (sub-sample of core module holdings).

The main proviso in the use of a sample-based core census module as a sampling frame for the census supplementary modules is that the core census sample must be big enough to provide sufficient sample for the supplementary modules. Thus, a sample of 100,000 holdings for the core census module might yield 10,000 holdings with aquaculture, more than sufficient for an aquacultural module. However, it might yield only 50 holdings growing potatoes, which would be insufficient for an in-depth potato survey. Economies should plan their agricultural census and survey program at the outset to ensure that data requirements can be met.

Part II. Practical Statistical Methodology

Technical Formulation for Survey Implementation

10. Sampling Schemes for the Agricultural Survey Program

Here we briefly describe some of the sampling procedures commonly followed in actual sample surveys. A sample must be representative of the population. The representative character of a sample is normally ensured through random selection procedures.

10.1 RANDOM SAMPLING

In random sampling procedures, selection of sample is done through a probability mechanism, so that all samples are provided a definite probability of selection. This is why, random sampling is also known as probability sampling. The simplest of all random sampling procedures is the one in which all possible samples are provided equal probability of selection. It is not always feasible, nor desirable, to generate all possible samples and then select one sample with equal probability. The procedure of selection, normally followed, is one after another draw procedure in which units are selected one after the other draw with equal probability of selection at each draw. This procedure is known as simple random sampling. In this procedure all population units have equal chance of selection. Thus, simple random sampling may be defined as follows:

> **Simple random sampling** is the method of selecting the units from the population where all possible samples are equally likely to get selected.

It follows that in simple random sampling every population unit has the same chance of being selected in the sample. Such sampling procedures are known as Equal Probability Selection Methods (*EPSEM*). It may be noted that simple random sampling is an *EPSEM* procedure, but all *EPSEM*s are not necessarily simple random sampling methods.

10.2 SYSTEMATIC SAMPLING

Systematic sampling is yet another method of selecting a sample. In simple random sampling the units were selected randomly at each draw. In systematic sampling the whole sample is selected with just one random number. The procedure is defined as follows:

> **Systematic sampling** is a method of sample selection in which only the first unit is selected at random and the rest of the units are automatically selected according to a predetermined pattern.

The most common predetermined pattern is the one in which after the random start, units are selected at equal intervals. This method is also known as linear systematic sampling.

Suppose we want to select a systematic sample of size n from a population consisting of N

units. The method of linear systematic sampling is employed when N is a multiple of n i.e. $N = n \cdot k$ where k is an integer. Let us assume that the nk serial numbers of the population units in the frame are arranged as follows:

1	2	3	…	r	…	k
k+1	k+2	k+3	…	k+r	…	2k
2k+1	2k+2	2k+3	…	2k+r	…	3k
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
(n-1)k+1	(n-1)k+2	(n-1)k+3	…	(n-1)k+r	…	nk

Select a random number r such that$1 \leq r \leq k$. The number r is called a random start and k is called sampling interval. The selected sample is the population units with serial numbers r,

r+k, …, r+ (n-1)k.

Systematic sampling is an *EPSEM* procedure. However, it is not equivalent to simple random sampling. The method has got advantage of simplicity in selection. However, the efficiency of estimation depends on the ordering of the units. With a suitable choice of arrangement, keeping in view the trends in the population, the method has got the potential of performing very well. It has got a limitation that an unbiased estimation of variance is not feasible with this method of sampling.

There are several other variants of systematic sampling, depending upon the systematic pattern used for selection. One such procedure is Circular Systematic Sampling, in which

random start is taken between 1 and N and then subsequent units are selected with equal interval after arranging the population units in a circular way. This method takes care of the situation when N is not multiple of n i. e. $N \neq nk$.

10.3 UNEQUAL PROBABILITY SAMPLING

Simple random sampling and systematic sampling are *EPSEM* procedures. However, when units vary considerably in sizes, providing equal chance of selection for every unit may not be a desirable proposition. Under such situations, selection of units with unequal probabilities may provide more efficient estimators. In this scheme, the units are selected with probability proportional to a given measure of size. The size measure is an auxiliary variable closely associated with the study variable. This method is known as varying probability sampling or probability proportional to size (*PPS*) sampling. For selecting a population unit with PPS, following methods are used:

10.3.1 Cumulative Total Method:

Let the size of the ^{ith} unit be denoted by X_i. Let the total size for N population units be, $X = \sum X_i$, i=1, N. Then the selection procedure consists of the following steps:

Step 1. Define cumulative totals

$T_{i-1} = X_1 + X_2 + \ldots\ldots\ldots + X_{i-1}$

$T_i = T_{i-1} + X_i ; i=2,\ldots, N$

Step 2. Chose a random number r such that $1 \leq r \leq k$

Step 3. Select i^{th} population unit if $T_{i-1} < r \leq T_i$

The probability of selecting the i^{th} population unit, using this procedure is given by $P_i = X_i/X$.

This procedure is described for selecting one unit with probability of selection P_i. It is observed that in this method, it is required to cumulate the sizes and write down these cumulative totals. The procedure becomes a bit tedious when population size N is large. A procedure which does not involve cumulating the sizes was given by D. B. Lahiri[10] and is described below:

10.3.2 Lahiri's Method:

Step 1. Select a random number (say) I from 1 to N.

Step 2. Select another random number (say) j, from 1 to M, where M is either equal to the maximum of the sizes $X_i; i=1, 2, \ldots.., N$ or is more than the maximum size in the population.

Step 3. If $j \leq X_i$, the i^{th} unit is selected, otherwise, the pair (i, j) of random numbers is rejected and another pair is chosen by repeating the steps 1 and 2.

The procedure is repeated till a unit is selected. This methods ensures that the probability of selection for i^{th} population unit is $P_i = X_i/X$.

10.3.3 Probability Proportional to Size (*PPS*) with and without replacement:

If n units are to be selected with replacement, the procedure is to be applied independently n times. Thus, conceptually, every selected unit is replaced to the population before next unit is selected again with the same probability measures. The estimation procedure for estimating population total and for estimating the sampling variances is simpler in this case. We are not describing the estimation procedure here.

For *PPS* sampling without replacement, the selected units are to be excluded from the population for subsequent draws and the selection and estimation becomes much more complex. Since estimation become somewhat involved, attempts have been made to make the estimation procedures somewhat simpler. We shall not get into vast area of sampling literature in varying probability without replacement. However, it is worthwhile to mention about a special category of varying probability without replacement procedure, which is commonly used in agricultural censuses as well as annual surveys. For sampling procedures with varying probabilities without replacement, if inclusion probabilities of sampling units are proportional to size measures, then estimation becomes very simple. Such procedures are

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[10] A method of sample selection providing unbiased ratio estimates, Lahiri, D. B., Bulletin of the International Statistical Institute, 33: 133 – 140, 1951.

called *Inclusion Probability Proportional to Size* (*IPPS*) procedures or πps procedure, since inclusion probabilities are sometimes denoted by π_i's. One such procedure is *PPS* systematic sampling which is described below:

10.3.4 Probability Proportional to Size (*PPS*) Systematic Sampling:

The procedure is described here for selection of enumeration area (EA) sampling units within a specific stratum.

Define:

N = number of EAs in the stratum

n = number of EAs to be selected in the stratum

z_i = the measure of size (*MoS* or number of agricultural households in this case) for the i^{th} EA in the stratum

$$Z = \sum_{i=1}^{N} z_i$$

$p_i = z_i / Z$ where i=1, ……, N

$\pi_i = np_i$ i=1, ……, N

The π_i values are the selection probabilities for the i^{th} EA. The *PP S* systematic sampling selection procedure is described in following steps:

Step 1: In this step, the procedure of implicit stratification is described. We consider a subadministrative (say, *SA*) level as implicit strata. Sort the list of EAs in the stratum by *SA* level. Within a PA, arrange the EAs in ascending order of MoS; then in the next SA arrange the EAs in descending order of *MoS*. Continue this sorting by alternating between ascending and descending sorting from one *SA* to the next. This type of sorting helps in improving the efficiency of *PPS* systematic sampling.

Step 2: Check that $np_i < 1$, i.e. z_i is less than Z/n for all i in the stratum.

Step 3: Compute cumulative totals

$C_1 = \pi_1$

$C_2 = C_1 + \pi_2$

.....

$C_{N-1} = C_{N-2} + \pi_{N-1}$

$C_N = C_{N-1} + \pi_N$ (Note that $C_N = n$)

Step 4: Generate a random number "r" between 0 and 1. Compute the numbers $r_i = r + i - 1$

with i = 1, 2, 3, ….., n+2.

Step 5: Select the n EAs with the labels $i_1, i_2, i_3, \ldots\ldots, i_n$ such that
$C_{i1-1} < r_1 \leq C_{i1}$

$C_{i2-1} < r_2 \leq C_{i2}$

$C_{i3-1} < r_3 \leq C_{i3}$

...

$C_{in-1} < r_n \leq C_{in}$

The procedure yields a sample of size n with *PPS* systematic sampling and the selection probabilities are given by $\pi_i = np_i$; i=1, 2, 3, ……,N.

In this procedure, the estimation of population total becomes very simple and the estimator is given by $\hat{Y} = \frac{1}{n} \sum_{i=1}^{n} \frac{y_i}{p_i}$

10.4 STRATIFICATION

The selection procedures described so far i.e. simple random sampling; systematic sampling and unequal probability sampling are all methods of selection. In order to improve the efficiency of estimators, sometimes the population is divided into certain number of groups, such that the variability within the group is minimum.

The procedure of partitioning the population into groups, called strata and then drawing a random sample independently from each stratum, is known as stratified random sampling. In fact, stratification is a control measure applied in the process of selecting a sample for improving the precision of estimates. Certain considerations need to be addressed while deciding about the stratification plans:

- 1. How many strata to be formed?
- 2. How to allocate the total sample size to different strata?
- 3. How to form the strata?

The basic considerations for all these questions are that the sampling variance should be minimized for a given cost or vice versa i.e. minimize the cost for a specified precision level. Following considerations should be kept in mind for stratified sampling.

- The strata should be non-overlapping and should together comprise the whole population.
- The strata should be homogeneous with respect to the study variable.
- Several rules are available in literature for demarcating the strata boundaries.

However, when it is difficult to stratify the population with respect to the study variable or a highly correlated auxiliary variable, the administrative convenience may be considered as a basis for stratification.

10.4.1 Number of Strata

Regarding the question of number of strata, it may be observed that the normally the efficiency of stratified sampling estimators increases with increase in number of strata. But rate of reduction in the variance decreases as the number of strata increases. Also, the cost of the survey is affected by increase in the number of strata. Based on certain theoretical and empirical considerations, Cochran (1977)[11] observed that if an increase in number of strata (say, L) beyond 6 necessitates any substantial decrease in sample size n in order to keep the cost constant, the increase will seldom be profitable. This indicates that if one is interested in overall estimates for the population mean/total, number of strata around six or seven should be reasonable enough. However, if estimates are wanted also for geographical subdivisions of the population, the argument for larger number of strata is stronger.

10.4.2 Allocation of Sample to Different Strata

Although the total sample size is generally obtained based on cost and variance considerations, the decision about allocating the total sample size to different strata has to be made before selecting the sample. Following methods are commonly available:

- 1. Equal allocation
- 2. Proportional allocation
- 3. Compromise allocation
- 4. Optimum allocation

We explain the allocations with the help of an example in which districts are not only strata, but the interest also lies in getting reliable district level estimates and also domestic level estimates. Enumeration Areas (EAs) are the sampling units. A given sample size of EAs is to be allocated to different strata (districts).

10.4.2.1 Equal Allocation: In this approach, the sample is allocated equally to each stratum. The strata sizes vary considerably and equal allocation will provide not so efficient estimates at higher levels as the districts will not get due representation in the sample. This allocation is therefore, not a suitable alternative.

10.4.2.2 Proportional Allocation: This allocation will provide sample sizes in proportion to strata sizes. This is a good alternative for provincial and domestic level estimates. Estimates for larger districts should be good enough, but smaller districts will have poor estimates.

10.4.2.3 Compromise Allocation: In this approach we try to get a balance between producing reliable district level estimates and reliable domestic level estimates. Sometimes a "square root" allocation is used, in which the sample is allocated in proportion to $\sqrt{x}$, where x is the measure of size. A more general allocation plan is the "power allocation" in which the sample is allocated in proportion to x^{λ}, where λ can take values between zero and 1. A suitable value of λ may be obtained by obtaining the design effects for domestic level estimates and also keeping in mind the requirement of getting reasonable district level estimates. Normally, using a value of λ = 0.4 or 0.5 is considered good enough in many situations.

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[11] Sampling Techniques, William G. Cochran, 3rd edition, John Wiley & Sons, New York, 1977.

10.4.2.4 Optimum Allocation: In this method variance of the stratified estimator is minimized with respect to a given cost. Let us consider a simple cost function:

$$C = c_o + \sum_{h=1}^{L} c_h n_h$$

where c_o is the overhead cost, c_h is the cost of observing study variable *y* for each unit selected in the sample from h^{th} stratum, h=1,…., L. After optimization, a fixed cost, or minimum variance allocation is given by:

$$n_h = \frac{(C-c_o)W_h S_h/\sqrt{c_h}}{\sum_{h=1}^{L} W_h S_h \sqrt{c_h}}$$

If the cost per unit is same for all the strata then the variance is minimized with respect to the restriction:

$$n = \sum_{h=1}^{L} n_h \text{ and } n_h \text{ is given by}$$

$$n_h = n\left(\frac{W_h S_h}{\sum_{h=1}^{L} W_h S_h}\right) = n\left(\frac{N_h S_h}{\sum_{h=1}^{L} N_h S_h}\right)$$

This allocation is also known as **Neyman's optimum allocation**.

10.5 CLUSTER SAMPLING AND MULTISTAGE SAMPLING

Consider the situation of agricultural censuses, in which agricultural holdings are the sampling units. In case, a list of all the holdings in a stratum (say district) is not available, a sample of holdings cannot be selected. Even if the list is available, a sample of holdings straightaway selected from the entire stratum will be scattered all over the stratum. This will involve lot of travel expenditure.

A list of EAs is usually available. Each EA is a group or cluster of households. If EAs are selected and all the agricultural households in the selected households are enumerated, then a considerably reduced number of EAs will account for the same number of agricultural households to be selected in the sample. The spread of selected households will be limited to the selected EAs only, thereby reducing the travel expenditure.

The cluster sampling consists of forming suitable clusters of contiguous population units and completely enumerating all the units in a sample of clusters, selected according to a suitable sampling scheme.

In terms of efficiency, cluster sampling is advantageous if clusters are heterogeneous with respect to study variable. In this respect, cluster sampling is converse of stratified sampling in the sense that both constitute of groups of units but strata should be homogeneous whereas clusters should be heterogeneous.

Multi stage sampling is a natural extension of cluster sampling. If the clusters are not completely enumerated, but units are further selected within selected clusters then it is called two stage sampling. Thus, in agricultural census example, if EAs are selected and then within

each selected EA, agricultural holdings are selected, the sampling is done in two stages. The selection may be extended to more than two stages and the procedure is termed as multistage sampling. The sampling units at the first stage are called first stage units (*FSU*s) or also primary sampling units (*PSU*s). The units at the second stage are termed as second stage units or secondary sampling units (*SSU*s).

An important feature of multi-stage sampling is that at different stages, samples are selected independently and different methods of selection may be used at different stages. For example, in two-stage sampling, *SRS without replacement (WOR)* method may be followed at both the stages. Particular cases of special interest are when *PPS* with replacement or *PPS* systematic sampling is followed at first stage and *SRS WOR* are followed at the second stage. The latter case, i.e. when PPS systematic sampling is followed at the first stage and *SRS WOR* at the second stage, is quite common in agricultural censuses and surveys. In this case, EAs are selected at the first stage with measures of sizes as the number of agricultural households in EAs and a given number of agricultural households are selected at the second stage in each of the selected EAs. This approach yields an *EPSEM* method of selection for each household. However, *EPSEM* nature of the selected sample is sometimes vitiated slightly due to differences in the size measure used in the selection process and actual number of agricultural households at the time of field work, when second stage selection of agricultural households actually takes place.

10.6 MULTIVARIATE PROBABILITY PROPORTIONAL TO SIZE (*MPPS*) SAMPLING

In *PPS* sampling, samples are selected with probability proportional to a size measure. The size measure is normally some auxiliary variable, which is highly correlated with the study characteristics. If there are several characteristics of interest, there may be a number of variables which may be correlated to the study variables. However, for sample selection with PPS, only one variable may be used. This variable could be a combination of auxiliary variables in order to generate a probability measure for selection. Multivariate approaches for generating a common index which could be used for selection purposes are sometimes used. The situation of several study characteristics of interest is very common in agricultural censuses and surveys. The characteristics related to different themes of supplementary modules are simple examples of multiple characteristics of interest.

An approach of *MPPS* as used in Censuses and surveys used in China[12] is described below.

where: N = Number of units in the population

N_k= Number of units in the population having k^{th} characteristic (k=1, …, K)

n_k= Number of units to be selected for the k^{th} characteristic).

X_{ik}= value of the k^{th} auxiliary variable for i^{th} population unit.

[12] Improvements of Sample Design for Rural Statistical Surveys in China, Michael Steiner, USDA/NASS, 2000.

$$X_k = \sum_{i=1}^{N_k} X_{ik}$$

$$p_{ik} = \left(\frac{X_{ik}}{X_k}\right)$$

$\pi_{ik} = n_k p_{ik}$

$$\pi_i = Max(\pi_{i1}, \pi_{i2}, \ldots, \pi_{iK})$$

In *MPPS* procedure, for selecting i^{th} unit, select a random number r_i (say) between 0 to1. If

$r_i \leq \pi_i$, then i^{th} unit is selected, otherwise rejected. Continue this procedure independently for all the N units in the population. Essentially, the procedure is a Bernoulli's trial experiment with π_i as the probability of selection for i^{th} unit.

The procedure ensures that the individual selection probabilities for different characteristics are taken into account and maximum one is taken as the selection probability for i^{th} unit. The probability π_i serves as an index value based on all the auxiliary characteristics.

For estimation purposes, $w_i = \left(\frac{1}{\pi_i}\right)$ serves as the basic weight.

11. Determination of Sample Size

Determination of sample size is one of the initial questions which a survey statistician has to face while planning any sample survey. Cost and variance are the prime considerations while working out the sample size requirement. In random sampling, sampling variances are generally expressed as a function of sample size it reduces with increase in sample sizes. Cost of the survey is an increasing function of the sample size. Thus, increasing the sample size reduces the variance but it increases the cost. For a desirable sampling size, a balance is needed between cost and variance.

11.1 PRINCIPAL STEPS IN CHOOSING A SAMPLE SIZE

The principal steps involved in the choice of a sample size are as follows:

1. There must be some statement concerning the desired limits of error. In other words some statement is needed as to what is the tolerable margin of error in the estimates. This statement has to come from the persons, who wish to use the results.
2. Some statement that connects the sample size ***n*** with the desired precision of the sample must be found. One of the advantages of probability sampling is that sampling variances which measure the precision can be expressed in terms of ***n***.
3. Sampling variances are population parameters and it contains some parametric values which need to be estimated in order to give specific results. For example, in simple random sampling, the sampling variance is a function of ***n*** but it has also got mean squares i.e. $\boldsymbol{S}^2$.
4. Finally, the chosen value of n must be appraised to see whether it is consistent with the resources available to take the sample.

We consider the case of simple random sampling for quantitative character *y*, to demonstrate the steps needed for determining the sample size. Let *r* be the margin of relative error to be tolerated in estimating the population mean $\bar{Y}$. An unbiased estimator of population mean $\bar{Y}$ is the sample mean $\bar{y}$. We want

$$\Pr\left[\left|\frac{\bar{y}-\bar{Y}}{\bar{Y}}\right| \geq r\right] = \Pr[|\bar{y} - \bar{Y}| \geq r\bar{Y}] = \alpha ,$$

where α is a small probability. We assume that $\bar{y}$ is normally distributed. Also, the standard error of $\bar{y}$ is

$$\sigma_{\bar{y}} = \sqrt{\frac{N-n}{N}} \cdot \frac{S}{\sqrt{n}}$$

Hence

$$r\bar{Y} = t \cdot \sigma_{\bar{y}} = t \cdot \sqrt{\frac{N-n}{N}} \cdot \frac{S}{\sqrt{n}}$$

Solving for ***n*** gives

$$n = \left(\frac{tS}{r\bar{Y}}\right)^2 \Big/ \left[1 + \frac{1}{N}\left(\frac{tS}{r\bar{Y}}\right)^2\right]$$

Here, $\left(\frac{S}{\bar{Y}}\right)$ is the coefficient of variation which is a fairly stable quantity. In order to calculate ***n***, we need an approximate idea about this coefficient of variation.

As a first approximation, we take

$$n_o = \left(\frac{tS}{r\bar{Y}}\right)^2 = \frac{1}{C} \cdot \left(\frac{S}{\bar{Y}}\right)^2$$

If $\left(\frac{n_o}{N}\right)$ is appreciable, we compute ***n*** as

$$n = \left[\frac{n_o}{1+\left(\frac{n_o}{N}\right)}\right]$$

In case of qualitative characteristics if a **proportion P** is to be estimated and *p* is the sample proportion, the sample size is given by

$$n = \frac{\left(t^2PQ/d^2\right)}{1+\left(\frac{t^2PQ}{d^2}-1\right)/N}$$

If N is large, a first approximation is

$$n_o = \left(\frac{t^2PQ}{d^2}\right) \quad \text{and} \quad n = \left[\frac{n_o}{1+\left(\frac{n_o}{N}\right)}\right]$$

It should be noted that $d = r\bar{Y}$ and when the population mean is not known then a survey estimate, $\hat{Y}$, can be substituted as the best estimate of the population mean.

11.2 DESIGN EFFECT AND ITS ROLE IN SAMPLE SIZE DETERMINATION FOR COMPLEX DESIGNS

What has been described above is a procedure for determining the sample sizes in simple random sampling without replacement. In actual practice designs are much more complex. Kish[13] described **Deff** as ratio of the variance of the estimate obtained from the (more complex) sample to the variance of the estimate obtained from a simple random sample of the same number of units. The sample size as obtained for simple random sampling is multiplied by **Deff** in order to get the required sample size for the complex design. The concept was

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[13] Survey Sampling, Leslie Kish, John Wiley & Sons, New York, 1965.

initially given in the context of cluster sampling. In cluster sampling with equal clusters, the design effect is given by $\{1+ (M - 1)\rho\}$, where M is the cluster size and ρ is the intra-class correlation. In actual practice, the design effect is worked out from previous surveys and is used to determine the required sample size for the current survey. If the complex design is more efficient than the simple random sampling, value of **Deff** will be less than one and the required sample size will be smaller than the one obtained for simple random sampling. On the other hand if **Deff** is more than one, the required sample size will be more than the one obtained on the basis of simple random sampling.

12. Estimation Procedures

One of the main objectives of conducting sample surveys is to estimate population parameters of interest. Quite often, the interest lies in estimating parameters like population mean/total, sampling variances etc. Keeping in view the parameter of interest, estimators are chosen satisfying desirable properties like unbiased-ness, efficiency etc. For every sampling design, the estimation procedure invariably includes estimator of the parameter and estimators for sampling variance, which is a measure of the precision of the estimator.

Let us consider the estimators of population mean $\bar{\boldsymbol{Y}}$ or population total $\bar{\boldsymbol{Y}} = \mathrm{N} \cdot \bar{\boldsymbol{Y}}$ and estimators of sampling variances in case of some of the prevalent sampling designs. A discussion of the Coefficient of Variation (CV) is presented as a means of accessing the degree of variability compared to the estimate.

12.1 SIMPLE RANDOM SAMPLING (*SRS*)

For both **with replacement** (*WR*) as well as **without replacement** (*WOR*) cases, sample mean $\bar{y} = \frac{1}{n} \cdot \sum_{i=1}^{n} y_i$ is an unbiased estimator of the population mean $\bar{Y}$.

Estimator of sampling variance in the case of SRS *WR* is given by

$$\hat{V}(\bar{y}) = \left(\frac{s^2}{n}\right) ; \text{ where } s^2 \text{ is the sample mean square given by } s^2 = \left(\frac{1}{n-1}\right) \cdot \sum_{i=1}^{n} (y_i - \bar{y})^2 .$$

In case of SRS *WOR*, estimator of variance is given by

$$\hat{V}(\bar{y}) = \left(\frac{1}{n} - \frac{1}{N}\right) \cdot s^2 \ .$$

12.2 SYSTEMATIC SAMPLING (*SRS*)

For linear systematic sampling, with N being a multiple of ***n***, systematic sampling is an *EOSEM* procedure and sample mean $\bar{y}$ is an unbiased estimator of population mean $\bar{Y}$. Unbiased estimation of variance is not possible in this case, however, some approximations are available. One such approximation is as follows:

$$\hat{V}(\bar{y}) = \frac{1}{2} \cdot \left(\frac{1}{n} - \frac{1}{N}\right) \cdot \left(\frac{1}{n-1}\right) \cdot \sum_{i=1}^{n-1} (y_{i+1} - y_i)^2$$

However, if it is assumed that population is randomly distributed, then the same expression as used in case of simple random sampling may be used , i.e.

$$\hat{V}(\bar{y}) = \left(\frac{1}{n} - \frac{1}{N}\right) \cdot s^2 \ .$$

12.3 PROBABILITY PROPORTIONAL TO SIZE SAMPLING WITH REPLACEMENT (*PPS WR*)

For *PPS WR*, the estimator of the population total is given by

$$\hat{Y}_{pps} = \frac{1}{n} \cdot \sum_{i=1}^{n} \frac{y_i}{p_i},$$

where p_i's are the initial probabilities of selection. The unbiased estimator of the sampling variance is given by,

$$\hat{V}\left(\hat{Y}_{pps}\right) = \frac{1}{n(n-1)} \cdot \sum_{i=1}^{n} \left(\frac{y_i}{p_i} - \hat{Y}_{pps}\right)^2 .$$

12.4 VARYING PROBABILITY SAMPLING WITHOUT REPLACEMENT (*PPS WOR*)

Most common estimator of population total *Y* in case of *PPS WOR* schemes is due to Horvitz and Thompson[14] and is given as follows:

$$\hat{Y}_{HT} = \sum_{i=1}^{n} \frac{y_i}{\pi_i}$$

where π_i is the selection probability or the probability of inclusion of i^{th} population unit in the sample. Calculation of inclusion probabilities in general *PPS WOR* schemes is quite complicated and efforts have been made to either suggest estimators which do not require calculation of inclusion probabilities or to suggest varying probability without replacement schemes in which selection probabilities are proportional to size measures used for selection. These schemes are known as IPPS or *πps* schemes. One of the IPPS schemes is *PPS-systematic sampling*, which has already been described in the section 11.3. In IPPS schemes, $\pi_i = n \cdot p_i$. Thus,

$$\hat{Y}_{HT} = \left(\frac{1}{n}\right) \cdot \sum_{i=1}^{n} \frac{y_i}{p_i}$$

which is of the same form as the estimator in *PPS WR* case. As in the case of systematic sampling, in this case also unbiased estimation of sampling variance is not possible. However, variances are estimated under some approximations and assumptions. Quite often, software packages for estimation of variances for complex sample surveys are used. Some of the methods used are sample re-use procedures, which are quite computer intensive methods. Simple expressions for estimators of variances are not available.

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[14] Horvitz, D.G. & Thompson, D.J. (1952). A generalization of sampling without replacement from a finite universe. Journal of the American Statistical Association 47(260): 663-685.

12.5 STRATIFIED SAMPLING

In stratified sampling, samples are selected independently within each stratum. The estimation procedure depends on the method of sampling used within each stratum. Here, we consider the estimation procedure when *SRS WOR* method has been used within strata.

An unbiased estimator of population mean is given as

$$\hat{\bar{Y}}_{st} = \sum_{h=1}^{L} W_h \bar{y}_h$$

An unbiased estimator of sampling variance is given by

$$\hat{V}\left(\hat{\bar{Y}}_{st}\right) = \sum_{h=1}^{L} {W_h}^2 \left(\frac{1}{n_h} - \frac{1}{N_h}\right) {s_h}^2$$

Where $W_h = \left(\frac{N_h}{n_h}\right)$ represents the "weights" of each stratum.

The estimators will depend on the method of sampling used within strata. If it is *PPS* selection, the formulae will change accordingly.

12.6 CLUSTER SAMPLING

We consider the case of equal clusters of size *M* each. Let ***n*** clusters be selected from *N* clusters using *SRS WOR*. Define Y_{ij} = value of the character under study for j^{th} unit in the i^{th} cluster

$Y_{i.}$ = total for the i^{th} cluster

$Y_{..}$ = total of the *y*-values for all the units in the population

$\bar{Y}_i$ = per unit i^{th} cluster mean

$y_{i.}$ = i^{th} sample cluster total

$\bar{y}_i = \left(\frac{1}{M}\right) \cdot \sum_{i=1}^{M} y_{ij}$ = per unit i^{th} sample cluster mean

$\bar{y}_c = \left(\frac{1}{n}\right) \cdot \sum_{i=1}^{n} y_{i.}$ = mean per cluster in the sample

$\bar{Y} = \left(\frac{1}{NM}\right) \cdot \sum_{i=1}^{N} \sum_{j=1}^{M} y_{ij}$ = Population mean

$\bar{Y}_c = \left(\frac{1}{N}\right) \cdot \sum_{i=1}^{N} \sum_{j=1}^{M} y_{ij}$ = M·$\bar{Y}$ = Population mean per cluster

An unbiased estimator of population mean is

$$\hat{\bar{Y}}_{cl} = \frac{1}{n} \cdot \sum_{i=1}^{n} \bar{y}_i$$

The variance estimator of the population is given by

$$V\left(\hat{\bar{Y}}_{cl}\right) = \left(\frac{1}{n} - \frac{1}{N}\right) \cdot \frac{1}{N-1} \cdot \sum_{i=1}^{N} \left(\bar{Y}_i - \bar{Y}\right)^2$$

An estimator of the cluster sample variance is given by

$$V\left(\hat{\bar{Y}}_{cl}\right) = \left(\frac{1}{n} - \frac{1}{N}\right) \cdot \frac{1}{n-1} \cdot \sum_{i=1}^{n} \left(\bar{y}_i - \hat{\bar{Y}}_{cl}\right)^2$$

For unequal clusters also estimation procedure is available, but several alternative estimators are considered depending upon whether population total is known or not. An alternative form for the $V\left(\hat{\bar{Y}}_{cl}\right)$ is approximated as

$$V\left(\hat{\bar{Y}}_{cl}\right) = \frac{S^2}{n} \cdot \{1 + (M-1)p\}$$

where ρ is the intra class correlation. In fact this very form of the variance leads to the well known form of Design Effect as $\{1 + (M-1)p\}$.

12.7 MULTISTAGE SAMPLING

Consider the case of two stage sampling of unequal PSUs where selection at both the stages is done with *SRS WOR*. Define the following:

N = number of PSUs in the population

n = number of PSUs selected in the sample

M_i = number of SSUs in the i^{th} PSU

m_i = number of SSUs selected in the i^{th} PSU

Y_{ij} = value of the study variable *y* for the ij^{th} SSU

y_{ij} = value for the study variable in the j^{th} selected SSU in the i^{th} selected PSU

Y_i = total of *y* values in the i_{th} PSU

Y = total of *y* values in the entire population

$\bar{Y}_{ts}$ = Mean per SSU in the i^{th} PSU

$\bar{y}_i$ = mean per SSU as obtained in the sample

An unbiased estimator of the population total Y is given by

$$\hat{Y}_{ts} = \frac{N}{n} \cdot \sum_{i=1}^{n} \frac{M_i}{m_i} \cdot \sum_{j=1}^{m_i} y_{ij} = \frac{N}{n} \cdot \sum_{i=1}^{n} M_i \bar{y}_i$$

The variance estimator of the population is given by

$$V\left(\hat{Y}_{ts}\right) = N^2 \left(\frac{1}{n} - \frac{1}{N}\right) \cdot S_{bt}^2 + \frac{N}{n} \cdot \sum_{i=1}^{N} M_i^2 \left(\frac{1}{m_i} - \frac{1}{M_i}\right) S_i^2$$

where $S_{bt}^2 = \frac{1}{N-1} \cdot \sum_{i=1}^{N} \left(Y_i - \frac{1}{N} \sum_{i=1}^{N} Y_i\right)^2$ and $S_i^2 = \frac{1}{M_i - 1} \cdot \sum_{j=1}^{M_i} \left(Y_{ij} - \frac{1}{M_i} \sum_{j=1}^{M_i} Y_{ij}\right)^2$

An estimator of the multi-stage sample variance is given by

$$V(\hat{Y}_{ts}) = N^2\left(\frac{1}{n}-\frac{1}{N}\right)\cdot s_{bt}^2 + \frac{N}{n}\cdot\sum_{i=1}^{n} M_i^2\left(\frac{1}{m_i}-\frac{1}{M_i}\right)s_i^2$$

where $s_{bt}^2 = \frac{1}{n-1}\cdot\sum_{i=1}^{n}\left(\hat{Y}_i - \frac{1}{n}\sum_{i=1}^{n}\hat{Y}_i\right)^2$; $\hat{Y}_i = \frac{1}{m_i}\sum_{j=1}^{m_i} y_{ij}$,

and $s_i^2 = \frac{1}{m_i-1}\cdot\sum_{j=1}^{m_i}\left(y_{ij} - \frac{1}{m_i}\sum_{j=1}^{m_i} y_{ij}\right)^2$

In case of equal clusters where $M_i=M$ and $m_i=m$, if mean is to be estimated the above formulae reduce to a simpler form as follows:

$$\hat{\bar{Y}} = \frac{1}{nm}\cdot\sum_{i=1}^{n}\sum_{j=1}^{m} y_{ij} = \sum_{i=1}^{n}\bar{y}_i$$

$$V\left(\hat{\bar{Y}}\right) = \left(\frac{1}{n}-\frac{1}{N}\right)\cdot S_b^2 + \frac{1}{N}\cdot\left(\frac{1}{m}-\frac{1}{M}\right)\bar{S}_w^2$$

where $S_b^2 = \frac{1}{N-1}\cdot\sum_{i=1}^{N}(\bar{Y}_i - \bar{Y})^2$; $\bar{S}_w^2 = \frac{1}{N}\cdot\sum_{i=1}^{N} S_i^2$ and $S_i^2 = \frac{1}{M-1}\cdot\sum_{j=1}^{M}\left(Y_{ij} - \bar{Y}_i\right)^2$

In the population variance formula as given above, the two components denote the contributions towards the total sampling variance due to between *PSU*s and within *SSU*s respectively. This splitting the variance into parts representing different stages of selection is very helpful in optimizing the sample sizes for two stages.

An estimator of a two-stage sample variance is given by:

$$V\left(\hat{\bar{Y}}\right) = \left(\frac{1}{n}-\frac{1}{N}\right)\cdot s_b^2 + \frac{1}{n}\cdot\left(\frac{1}{m}-\frac{1}{M}\right)\bar{s}_w^2$$

where $s_b^2 = \frac{1}{n-1}\cdot\sum_{i=1}^{n}(\bar{Y}_i - \bar{Y})^2$; $s_w^2 = \frac{1}{n}\cdot\sum_{i=1}^{n} s_i^2$ and $s_i^2 = \frac{1}{m-1}\cdot\sum_{j=1}^{m}\left(y_{ij} - \bar{y}_i\right)^2$

If *N* is large enough it creates a valuation near zero for the population fraction $\left(\frac{1}{N}\right)$ and can be ignored in the formulation, and as a result we obtain a simple and reduced expression for the estimator of variance as:

$$V\left(\hat{\bar{Y}}\right) = \left(\frac{1}{n}\right)\cdot s_b^2$$

12.8 ROLE OF SAMPLE WEIGHTS IN ESTIMATING POPULATION TOTALS AND MEANS

It may be observed from the above discussions that sampling weights have got important roles to play in estimation of various parameters. Quite often we are interested in parameters like totals and means which are linear in nature. The estimates for such parameters are also linear in nature with sample observations suitably weighted with appropriate sampling

weights. In agricultural censuses, since sampling is done for small and medium agricultural households only, the weighting procedure is considered only for such households. Large farms and institutional holdings are anyway completely enumerated. Corresponding weights for such holdings will be one only. The weighting procedure is essentially based on following three types of weights:

- 1) Base weights
- 2) Non response adjustments
- 3) Post-stratification adjustments

12.8.1 Base Weights

It may be observed that in varying probability sampling without replacement, Horvitz-Thompson estimator is given as:

$$\hat{Y}_{HT} = \sum_{i=1}^{n} \frac{y_i}{\pi_i} = \sum_{i=1}^{n} w_i y_i$$

where the weights are inverse of selection probabilities of the ultimate units. In agricultural censuses, operational holdings are the units of observation. Since the selection probabilities are associated with the units of selection, which are agricultural households in this case, the agricultural households associated with the holding provide the base weights for the holdings. If there is one to one correspondence between agricultural households and holdings, the selection probabilities of the holdings are straightaway the selection probabilities of the agricultural households. There is no problem for multiple-holding households, as the selection probabilities for such holdings are straight forward. In the cases where one operational holding corresponds to several agricultural households, pro-rata adjustments may be done by considering pseudo-holdings corresponding to each household. However, such cases are likely to be very rare.

In two stage sampling, the selection probability of a *SSU* is the product of selection probability of corresponding *PSU* and the conditional selection probability of *SSU* for the given PSU. In the present case, EAs are *PSU*s which are selected with *PPS* systematic sampling and agricultural households are *SSU*s which are selected with equal probability sampling. Let π_i be the probability of selection for i^{th} PSU (i.e. EA) and $\pi_{j|i}$ be the conditional probability for selecting j^{th} SSU (household) in i^{th} PSU, then the probability of selection for j^{th} SSU in i^{th} PSU is given by $\pi_{ij} = \pi_i \, \pi_{j|i}$. In this case,

$\pi_i = n \cdot \left(\frac{X_i}{X}\right)$; X_i = the measure of size (number of agricultural households in i^{th} EA as per Household Census) and X = the sum of X_i in the specific stratum to which i^{th} EA belongs. Also, $\pi_{j|i} = \left(\frac{m}{M_i}\right)$ where M_i is the number of agricultural households in i^{th} EA as observed at the time of field work for preparing the frame and *m* is the number of households selected in each EA. Thus, $\pi_{ij} = \left(\frac{nmX_i}{XM_i}\right)$.

In case when $X_i = M_i$, then $\pi_{ij} = \left(\frac{nm}{X}\right)$ and the sample design is *EPSEM*. However, when $X \neq M_i$, the design is no more EPSEM and the base should be calculated carefully.

In general, the **base weights** for each household in the i^{th} EA is = $\left(\frac{XM}{nmX_i}\right)$.

12.8.2 Nonresponse Adjustment

Invariably, there is some amount of non-response in every survey, which disturbs the weights. Therefore there is a need for adjusting for non-response. Normally, the non-response adjustments are done within each EA. The adjustment factor is (*m/r*), where *m* is the number of sampled holdings while *r* is the number of responding households.

12.8.3 Post-Stratification Adjustment

Sometimes it is felt desirable that the estimated totals for certain characteristics (auxiliary variables) in some population groups (which may as well be post-strata) are in conformity with the known totals for these groups. Some characteristics from a Household Census for which information is also collected the Agricultural Survey may serve as a suitable variable for this adjustment.

For example, number of households in a district may be known from Household Census. An estimate for this characteristic may also be developed from the survey. The weights may be adjusted in such a way that the estimated value is equal to the known value from the Household Census. This type of adjustment provides a check on the face value of the estimates with respect to known characteristics. Since the auxiliary characteristic is also correlated to the main study variable, the adjustment is also expected to provide more reliability to the estimates. The final weights are the product of base weight, non-response adjustment and the post stratification adjustment.

12.9 MEASURES OF ESTIMATOR VARIABILITY

As described in the earlier sections of this chapter, estimation of variance should be an integral part of estimation procedures. Estimation of variance provides a measure of precision for the point estimates, i.e. means, totals. The *CV* provides an objective measure as to the degree of variability inherent in the estimates developed. A lower value of the *CV* will provide to the data user a higher level of confidence in the degree of accuracy associated with the estimates.

12.9.1 Coefficient of Variation (*CV*)

The *Coefficient of Variation* is a convenient statistic for measuring precision of an estimator for a parameter (say, *Y*) which is defined for a population as follows:

$$CV = \left(\frac{\sqrt{sampling\ variance}}{parameter}\right)$$

and can be estimated from sample data as:

$$\widehat{CV} = \left(\frac{\widehat{SE}}{Point\ Estimator}\right) \cdot 100\% \ ;$$

where *SE* is an estimate obtained from sample data of the *Standard Error of the Point Estimator (Mean or Total)*.

Since the *CV* is a unit free measure, it is often used to compare the precision levels of estimators in different populations.

12.9.2 Confidence Interval

Another useful concept associated with precision levels is the concept of *Confidence Intervals* (*CI*). The concept of confidence limits and confidence interval is closely linked to interval estimation. A point estimate is a single value given as the estimate of a population parameter that is of interest, for example the mean of some quantity. An interval estimate specifies instead a range within which the parameter is estimated to lie. A confidence interval (*CI*) can be used to describe how reliable survey results are. For a given point estimate, 90% or 95% confidence intervals can be generated depending upon whether the level of confidence is 10% or 5%. When mean is to be estimated, in case of simple random sampling, sample mean $\bar{\boldsymbol{y}}$ is a point estimate for population mean $\bar{\boldsymbol{Y}}$ and the confidence limits are determined as:

$$CI_{(1-\alpha)} = \bar{y} \pm t_{\alpha}\, SE(\bar{y}) ,$$

where t_{α} is the *t*-value with (1 - α) per cent level of confidence and the $SE(\bar{y})$ is the *Standard Error of the Mean*. At a given level of confidence, and all other things being equal, a result with a smaller *CI* is more reliable than a result with a larger *CI*. A major factor determining the expanded width of a confidence interval is the size of the sample used in the estimation procedure.

Confidence intervals are closely related to statistical significance testing, i.e. The Student's *t*-Test[15]. In many situations, if the point estimate of a parameter is *X*, with confidence interval [a, b] at confidence level P, then any value outside the interval [a, b] will be significantly different from *X* at significance level $\alpha = 1 - P$, under the same distributional assumptions that were made to generate the confidence interval.

[15] Student's t-Tests. "Student" (real name: W. S. Gossett [1876-1937]) developed statistical methods to solve problems stemming from his employment in a brewery.

13. Nonlinear Variance Estimation in Complex Surveys

In the estimation procedures corresponding to different sampling designs as described in the previous chapter, formulae for estimates of variances for estimated means and totals are provided. In the case of linear estimates it is simple. However, in more complex survey situations, it is not always possible to express the estimated variances in terms of simple formulae. Even in more familiar situations of estimating variances for ratio and regression estimators, which are non-linear in nature, expressing variance estimators, similar to linear estimators is not feasible.

Several alternate methods for estimating variances in complex survey situations are available. Some of these methods are:

- Linearization (Taylor's series)
- Random Group Methods
- Balanced Repeated Replication (BRR)
- Resampling techniques (Jackknife and Bootstrap)

13.1 TAYLOR'S SERIES LINEARIZATION METHOD

In this method, non-linear statistics are approximated to linear form using Taylor's series expansion. This involves expressing the estimate in terms of a Taylor's series expansion, and then approximating the variance of the estimate by the variance of the first-order or linear part of the Taylor series expansion. This method requires the assumption that all higher order terms are of negligible size. If this assumption is correct, then the variance approximation works well. In this linearization approach to variance estimation, a separate formula for the linearized estimate must be developed for each type of estimator. We are already familiar with this approach in a simple form in case of ratio estimator.

13.2 RANDOM GROUP METHODS

This concept is based on the concept of replicating the survey design. The earliest form of this method is available in the concept of Interpenetrating samples. However it is usually not possible to replicate the survey. In such cases, survey can be divided into *R* groups so that each group forms a miniature version of the survey. Based on each of the *R* groups estimates can be developed for the parameter of interest θ, (say). Let $\hat{\theta}_r$ be the estimate based on r^{th} sample. Considering the groups as independent, an unbiased estimate of variance of

$\hat{\theta} = \frac{1}{R} \sum_{r=1}^{R} \hat{\theta}_r$ is given as:

$$\hat{V}(\hat{\theta}) = \frac{1}{R(R-1)} \sum_{r=1}^{R} \left(\hat{\theta}_r - \hat{\theta}\right)^2$$

Advantages of this method are that it is easy to calculate and it is a general method in which complex functions can be tackled easily. However, the assumption of independent samples may be somewhat restrictive, if samples are not selected independently.

13.3 BALANCED REPEATED REPLICATIONS METHODS

Consider that there are H strata with two units selected per stratum. There are 2^H ways to pick 1 from each stratum. Each combination could be treated as a sample. Pick *R* samples.

Which samples should we include? Following steps may be followed:

- Assign each value either 1 or –1 within the stratum
- Select samples that are orthogonal to one another to create balance
- One can use the design matrix for a fraction factorial
- Specify a vector α_r of 1, -1 values for each stratum

An estimator of variance based on *BRR* method is given by:

$$\hat{V}_{BRR}(\hat{\theta}) = \frac{1}{R(R-1)} \sum_{r=1}^{R} \left(\hat{\theta}(\alpha_r) - \hat{\theta}\right)^2 \text{ where } \hat{\theta} = \frac{1}{R} \sum_{r=1}^{R} \hat{\theta}(\alpha_r)$$

Some of the advantages in this method are that it has relatively few computations and it is asymptotically equivalent to linearization methods for smooth functions of population totals.

13.4 RESAMPLING TECHNIQUES

13.4.1 Jack-knife Method

The method was initially developed by (Quenouille, 1949)[16] in the context of reducing the bias of ratio estimator. The procedure was to randomly divide the sample (*SRS*) in two parts. Each part could provide an estimate of the estimator (ratio estimator in this case). The third estimate could be developed from the whole sample. These three estimators could be combined linearly such that first order term in the bias expression vanishes. If units are dropped individually, the corresponding statistics was found (conjectured first by Tukey, (1958)[17] to be uncorrelated. This property has been exploited for variance estimation.

Let $_i\hat{\theta}$ be the estimator of θ after omitting the i_{th} observation. Define $\tilde{\theta}^i = n\hat{\theta} - (n-1)\hat{\theta}^i$.

The Jackknife estimate is given by: $\hat{\theta}_J = \frac{1}{n} \sum_{i=1}^{n} \tilde{\theta}^i$.

Jackknife estimator of the variance is given by: $\hat{V}_J(\hat{\theta}_J) = \frac{1}{n(n-1)} \sum_{i=1}^{n} \left(\tilde{\theta}^i - \hat{\theta}_J\right)^2$.

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[16] Problems in Plane Sampling. M. H. Quenouille. Source: Ann. Math. Statist. Volume 20, Number 3 (1949), 355-375.

[17] Bias and confidence in not-quite large samples, Ann. Math. Statist., 29, 614, [§1].

13.4.2 Bootstrap Method

This is also a re-sample technique, in which large numbers of samples are selected by equal probability sampling with replacement from the main sample. Similar to the estimate for the main sample, independent estimates are prepared for each sample. Estimate of variance is obtained from the repeated samples. An advantage of this method is that estimates of variance for complex statistics like Quantiles and median can be obtained.

All these variance estimation techniques are highly computer intensive. Most of the survey data analysis packages utilize one of these methods. Some of these packages are as follows:

- OSIRIS – BRR, Jackknife
- SAS – Linearization
- Stata – Linearization
- SUDAAN – Linearization, Bootstrap, Jackknife
- WesVar – BRR, JackKnife, Bootstrap

14. Evaluation and Treatment of Survey Nonsampling Errors

In the previous discussions on survey design and estimation methodology, the focus was on sampling errors only. There are, however, other sources of variation in surveys caused by non-sampling errors. All survey data are subject to error from various sources. The difference in the true value of the parameter and survey results is an error due to one reason or the other.

14.1 NONSAMPLING ERRORS

The sampling variance and mean square errors are measures of error due to sampling. All other types of errors from various sources are termed as non-sampling errors. Non-sampling errors arise mainly due to misleading definitions and concepts, inadequate frames, unsatisfactory questionnaires, defective methods of data collection, tabulation, coding, incomplete coverage of sample units etc. Sampling errors arise solely as a result of drawing a probability sample rather than conducting a complete enumeration. Non-sampling errors, on the other hand, are mainly associated to data collection and processing procedures.

14.1.1 TYPES OF NONSAMPLING ERRORS

Non-sampling errors arise due to various causes right from initial stage when the survey is being planned and designed to the final stage when data are processed and analyzed. Some of the factors contributing towards Non-sampling error are as follows:

1. Data specification being inadequate and/or inconsistent with respect to objectives of the survey.
2. Duplication or omission of units due to imprecise definition of the boundaries of area units, incomplete or wrong identification particulars of units or faulty methods of enumeration.
3. Inappropriate methods of interview, observation or measurement using ambiguous questionnaires, definitions or instructions.
4. Lack of trained and experienced field enumerators including lack of good quality field supervision.
5. Inadequate scrutiny of the basic data.
6. Errors in data processing operations such as coding, keying, verification, tabulation etc.
7. Errors during presentation and publication of tabulated results.

Five prominent components of *NSE*s are known as:

- Specification errors,
- Coverage errors,
- Measurement or response errors,
- Non-response errors, and
- Processing and programming errors.

These types or error are briefly discussed below:

14.1.1.1 Specification Errors

This occurs when the concept implied by the question is different from the underlying construct that should be measured. A simple question such as whether a household is an agricultural household can be subject to different interpretations. A person may be doing agriculture as an own account holder, he may be involved in agricultural activities as a part time activity. The meaning of the questions must be conveyed in an unambiguous way and must be properly understood by the respondent. Unless the right screening and filter questions are included in the questionnaire, the answers may not fully bring out the message behind the question.

14.1.1.2 Coverage Errors

In most area surveys primary sampling units comprise clusters of geographic units generally called enumeration areas (EAs). It is not uncommon that the demarcation of EAs is not properly carried out during census mapping. Thus households may be omitted or duplicated in the second stage frame. Updating of EA boundaries before the conduct of agricultural census becomes very important. Cartography of EAs is normally available from the population censuses, but updating of the selected EAs is an essential part of the cartography for agricultural censuses. Otherwise, exclusion of sample units in some EAs and duplication of units in other EAs are highly probable. Frame imperfections can bias the estimates in several ways: If units are not represented in the frame but should have been part of the frame, this results in zero probability of: selection for those units omitted from the frame. This leads to under-coverage. On the other hand if some units are duplicated; this results in over-coverage with such units having larger probabilities of selection.

It is important to note that sometimes there is a deliberate and explicit exclusion of sections of a larger population from survey population. Survey objectives and practical difficulties determine such deliberate exclusions. For example, when we define the agricultural households by putting certain cut-offs, some households are deliberately excluded. When computing non-coverage rates, members of the group deliberately and explicitly excluded should not be counted either in the survey population or under non-coverage. In this regard defining the survey population should be part of the clearly stated essential survey conditions. Non-coverage is often associated with problems of incomplete and faulty frames. If the flames are not updated or old frames are used as a device to save time or money, it may lead to serious bias.

The most effective way to reduce coverage error is to improve the frame by excluding erroneous units and duplicates and updating the frame through filed work to identify units missing from the frame. It is also important to undertake a good mapping exercise during the preparatory stages of a population and housing census. However, the frame prepared during

the census should be updated periodically. It is also imperative to put in place procedures that will ensure the coverage of all selected sample units.

14.1.1.3 Measurement Errors

These errors arise from the fact that what is observed or measured departs from the actual values of sample units. These errors center on the sustentative content of the survey such as definition of survey objectives, their transformation into able questions, and the obtaining, recording, coding and processing of responses. These errors concern the accuracy of measurement at the level of individual units. When we get responses from the selected units through a questionnaire and there the responses are different than the true values, these errors are called response errors. Inadequate instructions to field staff and inadequate training normally lead to response errors.

Mathematical treatment of measurement errors is available in the form of linear response error models (refer to Cochran, W. G., 1977)[18]. Such models have also been used in the treatment of interpenetrating net-work of sub-sampling which is used for estimating the enumerators' effect. The mathematical details are not given here.

14.1.1.4 Nonresponse Errors

Non-response refers to the failure to measure some of the sample units. Thus, failure to obtain observations on some units selected for the sample. It is instructive to think of the sample population as split into two strata, one consisting of all sample units for which measurements can be obtained and the second for which no measurements could be obtained.

In most cases non-response is not evenly spread across the sample units but is heavily concentrated among subgroups. As a result of differential non-response, the distribution of the achieved sample across the subgroups will deviate from that of the selected sample. This deviation is likely to give rise to non-response bias if the survey variables are also related to the subgroups. While non-response cannot be completely eliminated in practice, it could be overcome to a great extent by persuasion or by some other methods. One way of dealing this problem was due to Hansen and Hurwitz (1946)[19]. In this method the population was conceived as divided in two strata – respondents and non-respondents. From the non-respondents, a sub-sample is selected and special efforts are made to get response from these units. An estimation procedure is developed on the basis of suitably pooling the results of respondent and non-respondent groups. Yet another technique was developed by Politz and Simon (1949)[20] for reducing the bias without call backs by asking to the respondent as to how many times he was at home during the previous week.

There are two types of non-responses: unit non-response and item non-response. Unit non-response implies that no information is obtained from certain sample units. This may be because respondents refuse to participate in the survey when contacted or they cannot be

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[18] *Sampling techniques*, Cochran, W.G., 3rd ed, John Wiley & Sons, New York, 1977.

[19] The problem of non-response in sample surveys, Hansen, M.H. and Hurwitz, W.N.,. J. Am. Stat. Assoc., 41:517–529, 1946.

[20] An attempt to get the "not at homes" into the sample without callbacks, Politz, A. and Simmons, W., *Journal of the American Statistical Association* 44, 9-31, 1949.

contacted. Item non-response refers to a situation where for some units the information collected is incomplete. Item non-response is, therefore, evidenced by gaps in the data records for responding sample units. Reasons may be due to refusals, omissions by enumerators and incapacity.

14.1.1.5 Causes of Nonresponse

Respondents to provide information can cause non-response error if they are being not- at home or by sample units not being accessible. This introduces errors in the survey results because sample units excluded may have different characteristics from the sample units for which information was collected. Refusal by a prospective respondent to take part in a survey may be influenced by many factors, among them, lack of motivation, shortage of time, sensitivities of the study to certain questions, etc.

Errors arise from the exclusion of some of the units in the sample. This may not be a serious problem if the characteristics of the non-responding units are similar to those of the responding units. But such similarity is not common in practice.

With specific reference to item non-response, questions in the survey may be perceived by the respondent as being embarrassing, sensitive or/and irrelevant to the stated objective.

The enumerator may skip a question or ignore recording an answer. In addition, a response may be rejected during editing. For sensitive questions a technique of randomized response is available.

In personal interview surveys, the enumerator can play an important role in maximizing response from respondents. The way interviewers introduce themselves, what they say about the survey, the identity they carry, and the courtesy they show to respondents matter.

In most surveys the enumerator is the only link between the survey organization and respondent. It is for this reason that enumerators and their supervisors should be carefully selected, well trained and motivated. Close supervision of enumerator’s work and feedback on achieved response rate is of paramount importance.

14.1.1.6 Processing errors

Processing errors comprise:

- Editing errors.
- Coding errors.
- Data entry errors.
- Programming code mistakes, etc.

The above errors arise during the data processing stage. For example in coding open ended answers related to economic characteristics, coders may deviate from the laid out procedures in coding manuals, and therefore assign wrong codes to occupations. In addition, the weighting procedures may be wrongly applied during the processing stage, etc.

14.2 INTERPENETRATING SUBSAMPLING TO MEASURE INTERVIEWER EFFECTS AND ESTIMATION OF VARIANCE FOR COMPLEX SURVEYS

It is worthwhile to mention about this technique which was initially developed (Mahalanobis, 1946)[21] in the context of study of correlated errors. In this technique a random sample of *n* units is divided at random into k sub-samples, each sub-sample containing *m=n/k* units. The field work and processing of the sample are planned so that there is no correlation between the errors of measurement of any two units of in two different sub-samples. For instance, suppose that the correlation with which we have to deal arises solely from biases of the enumerators. If each of *k* enumerators is assigned to a different sub-sample and if there is no correlation between errors of measurement for different interviewers, we have an example of this technique. With a suitable model it is possible to estimate the relative amount which the correlated component (in this case due to interviewer's effect) of the response variance contributes to the total variance. The technique has also been very helpful in estimation of variances for complex statistics.

14.3 EVALUATION OF NONSAMPLING ERRORS

14.3.1 Consistency Checks

In designing the survey instruments (questionnaires), care should be taken to include certain items of information that will serve as a check on the quality of the data to be collected. If the additional items of information are easy to obtain, they may be canvassed for all units covered in the survey, otherwise, they may be canvassed only for a sub-sample of units. It is also desirable to follow some external consistency checks on salient results thorough comparable data sources. It is important for validity as well as acceptability of the estimates.

14.3.2 Sample Check/Verification

One way of assessing and controlling non-sampling errors in surveys is to independently duplicate the work at the different stages of operation with a view to facilitating the detection and rectification of errors. For practical reasons the duplicate checking can only be carried out on a sample of the work by using a smaller group of well-trained and experienced staff. If the survey is properly designed and if the checking operation is efficiently carried out, it would be possible, not only to detect the presence of non-sampling errors, but also to get an idea of their magnitude. If it were possible to completely check the survey work, the quality of the final results could be considerably improved. With the sample check, rectification work can only be carried out on the sample checked. This difficulty can be overcome by dividing the output at different stages of the survey, e.g. filled in schedules, coded schedules, computation sheets, etc., into lots and checking samples from each lot. In this case, when the error rate in a particular lot is more than the specified level, the whole lot may check and corrected fir the errors, thereby improving the quality of the final results.

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[21] Recent experiments in statistical sampling in the Indian Statistical Institute, Mahalanobis, P.C, J. Roy. Stat. Soc., 109, 325-370, 1946.

14.3.3 Post-Survey Checks

An important sample check, which may be used to assess non-sampling errors, consists of selecting a sub-sample, or a sample in the case of a census, and re-enumerating it by using better trained and more experienced staff than those employed for the main investigation. Usually the check-survey is designed to facilitate the assessment of both coverage and content errors. For this purpose, it is first desirable to re-enumerate all the units in the sample at the high stages, e.g. EAs and villages, with the view of detecting coverage errors and then to re survey only a sample of ultimate units ensuring proper representation for different parts of the population which have special significance from the point of view of non-sampling errors.

Appendix. Concepts and Definitions of Agricultural Census Items

This appendix contains a description of the concepts and definitions for the agricultural census core and supplementary items given in Chapter 3. The concepts and definitions have been developed taking into consideration international standards and the need for comparability with previous agricultural censuses and with other data sources. Any major changes from previous programs are highlighted. Economies will need to adapt the concepts and definitions given to meet their own needs and circumstances.

1. INTRODUCTION

A.1. This chapter provides recommended concepts and definitions for the agricultural census core and supplementary items shown in Chapter 4. The concepts and definitions are based on international standards, where applicable, to ensure that agricultural census results are comparable with other data sources. Where items were included in earlier agricultural census programs, the concepts and definitions are generally the same as those used previously. Explanations are provided, as needed, to help make comparisons with previous agricultural census data.

A.2. In an integrated agricultural statistics system, the need for uniformity in concepts and definitions between the agricultural census and other agricultural statistics is also important. Often, there are well-established standards for current agricultural statistics; for example, many economies already have standards for reporting on crops or seasons, which should be consistent with the agricultural census.

A.3. It is recognized that economies will need to adapt the standards given in this chapter to meet their needs and circumstances, but this should be done in such a way that the census data are compatible with international standards. Where it is necessary to depart from these standards, the differences should be highlighted in the presentation of the census results, and explanations given as to how the domestic data can be compared with those from other economies.

2 GENERAL CORE ITEMS

0001 Identification And Location Of Agricultural Holding

A.4. The location of the agricultural holding is needed to assign agricultural holdings to administrative units or agro-ecological zones, which are key classification items in the tabulation of agricultural census results. Usually, the location of a holding is identified by where the farm buildings and agricultural machinery are located. Care is needed if the holding comprises two or more parcels. Sometimes, the location of each parcel is also identified (see paragraph A.55). Often, the holder's residence is used as the holding location.

A.5. Location is normally identified through a geographic coding system, based on the administrative structure of the economy. Codes are provided for each administrative unit such as province, district and village. This identifies the location of the holding down to the lowest administrative unit. Where a standard geographic coding system exists, it should be used for the agricultural census to make it easier to link data between the different sources.

A.6. Other types of geo-coding systems can also be used. It is now possible to geo-reference holdings with the use of Global Positioning Systems, and economies are encouraged to move in this direction. This can help in the presentation of census results through Geographic Information Systems and to link data to other sources.

0002 Legal Status Of Agricultural Holder

- An individual
- Two or more individuals
- Juridical person

Holders may also be classified into the following sectors:

- Household sector
  - — Single-holding household
  - — Multiple-holding household
  - — Partnership of two or more households
- Non-household sector
  - — Corporation
  - — Cooperative
  - — Government
  - — Other

A.7. Item 0002 is about the legal status of the agricultural holder. Legal status refers to the juridical aspects under which the agricultural holding is operated. It also refers to other aspects about the type of holding. From the juridical point of view, a holding may be operated by a single individual, jointly by several individuals with or without contractual agreement belonging to the same or to different households, or by a juridical person: corporation, cooperative, governmental institution, church, etc. Legal status of holder is an important classification item especially in combination with the sector where the holder belongs (see paragraph A.8). This item can also be useful for sampling frame purposes.

A.8. The sector where the holder belongs may be classified as "household sector" and "non-household sector". Economies are encouraged to distinguish between these two sectors in the

census tabulation. Holdings in the household sector are holdings that are operated by household members. Usually there is only one holding in a household (single-holding household), but there can be two or more holdings in a household (multiple-holding household). A holding may also consist of a partnership of two or more households. In many developing economies, most agricultural holdings are in the household sector.

A.9. Non-household holdings are those in sectors other than the household sector. Corporations and cooperatives are defined within the context of domestic laws and customs. Cooperatives include several kinds of organizations in which the principles of individual, joint ownership or leasehold are combined to various degrees. The other sector includes tribes, clans, private schools and religious institutions. Government holdings are agricultural production entities operated by a central or local government directly or through a special body.

A.10. The reference period is the day of enumeration.

0003 Sex Of Agricultural Holder

- Male
- Female

A.11. Item 0003 is important for analyzing the gender aspects of agricultural production and, in particular, to examine the role of women in managing agricultural holdings. This item could also be useful as the basis for a sampling frame for special gender surveys.

A.12. Data on sex of agricultural holder is collected only for holdings in sector “single-holding household” in Item 0002. Data usually refer to the day of enumeration. Where there are two or more co-holders in a holding, the sex of each person should be reported.

A.13. It is not expected that the core census module will include the collection of demographic data for each person in the household, and therefore it would be necessary to collect data on the sex (and age) of the holder directly from the respondent. Where demographic data are collected, sex of holder can be determined by identifying the holder and linking this to the personal data (Item 0711).

0004 Age Of Agricultural Holder

A.14. Age of holder is important for studying the relationship between age and the characteristics of agricultural holdings and, in particular, to compare young and old farmers. It is also useful for analyzing gender issues.

A.15. Age refers to the age in completed years at the time of the census. The item is collected only for holdings in sector “single-holding household” in Item 0002. Where there are two or more co-holders in a holding, the age of each person should be reported. See Figure 12.1 for information on how to tabulate age of holder data.

A.16. For information on data collection issues, see paragraph A.13 and paragraph A.217.

0016 Other Economic Production Activities of the Holding's Enterprise

- Other agricultural production
- Agricultural services
- Hunting, trapping, game propagation and related service activities
- Forestry, logging and related service activities
- Fishing, aquaculture and related service activities
- Manufacturing
- Wholesale and retail trade
- Hotels and restaurants
- Other

A.17. By definition, an agricultural holding consists of the agricultural production activities of an enterprise, where an enterprise is a corporation, a government institution, or (most commonly) a household. An enterprise containing an agricultural holding may be engaged in production activities other than agricultural production. For example, a household may operate a shop or restaurant, in addition to operating the agricultural holding. Item 0016 is included in the core census module to understand the relationship between agricultural production activities and other economic production activities.

A.18. Other economic production activities are economic production activities undertaken by the enterprise, other than agricultural production on the holding. This may include fishing, collecting forestry products, craft activities, and operating a family business. It does not include paid work as an employee. Normally, the reference period is the census reference year.

A.19. Nine activity categories are shown, based on ISIC (Rev. 3.1) (UN, 2004b):

1. Other agricultural production refers to agricultural production activities of the enterprise outside the holding, such as where there are two holdings in a household.
2. Agricultural services cover agricultural production related work done under contract on other holdings.
3. Hunting, trapping, game propagation and related service activities include hunting for food, fur and skin.
4. Forestry, logging and related service activities include growing of standing timber, logging, gathering of wild forest materials, and forest management services. These activities may be undertaken on land forming part of the holding or elsewhere.
5. Fishing, aquaculture and related service activities cover commercial fishing and related activities, including aquaculture. These activities may be carried out on land forming part of the holding or elsewhere. Note that this activity class covers all aquacultural activities of the enterprise, whereas Item 0014 only covers aquaculture carried out in association with agricultural production.
6. Manufacturing includes a whole range of activities associated with transforming raw materials into new products. For households, the most common manufacturing activities are food processing, making clothes and other textile materials, tanning, and making wood products.

7. Wholesale and retail trade covers services associated with the sale of goods at the final stages of distribution, such as through a market or shop.
8. Hotels and restaurants cover all accommodation and food services.
9. Other covers all other economic production activities, including activities related to construction and transportation.

3. THEME 01: LAND

3.1.1 Core Items

0007 Area Of Holding According To Land Use Types

A.20. Land use refers to activities – such as growing crops, raising livestock or cultivating fish – carried out on the land making up the holding with the intention of obtaining products and/or benefits. Land use should be distinguished from "land cover", which describes the physical characteristics of the land, such as grassland or forest. In the agricultural census, the area of the holding is classified according to its main land use. See paragraphs A.40– A.45 for more information on area of holding.

A.21. There is no universally accepted standard land use classification. For the purposes of the agricultural census, it is recommended that seven basic land use classes be identified:

- land under temporary crops;
- land under temporary meadows;
- land temporarily fallow;
- land under permanent crops;
- permanent meadows and pastures;
- forest or other wooded land;
- other land.

A.22. Definitions of these land use classes are given in paragraphs A.27– A.37. For presenting agricultural census results, the seven land use classes need to be grouped in a suitable way. There are many ways to do this, using terms such as agricultural land, cultivated land, cropland and arable land. There are no standard definitions for many of these terms. For example, some economies define arable land as land that is potentially cultivable, whereas other economies consider it to be land under temporary crops or meadows. The FAO recommends the land use classification shown in Figure A-1.

Figure A-1
Classification of Land Use

I	II	III	IV
Agricultural land	Cropland	Arable land	Land under temporary crops
			Land under temporary meadows
			Land temporarily fallow
		Land under permanent crops	
	Permanent meadows and pastures		
Forest or other wooded land			
Other land			

A.23. This classification is a condensed version of the one used in earlier agricultural census programs. The main differences from the 2000 program are:

- The concept of “productive land” is no longer used. Economies wishing to continue to use this concept should define productive land as the sum of “agricultural land” and “forest or other wooded land”.
- The concept of “cultivated land” is no longer used. This is equivalent to “cropland” under the recommended classification.
- The category “land under protective cover” is no longer used in the classification. Land previously shown in this category is included under “arable land” or “land under permanent crops”. Data on land under protective cover are recommended for inclusion in the sample component of the agricultural census as Item 0327.
- “Other arable land” is included under “land temporarily fallow”.
- “Permanent meadows and pastures” is not further sub-divided by whether it is cultivated or naturally grown.
- “Other land” is not further sub-divided according to its potential for development.

A.24. An economy may prefer to use its own land use classes and classification because they are well-established and meet domestic needs. Economies doing so should ensure that the land use classes can be aggregated up to the seven basic land use types. Land use data should also be presented according to the FAO recommendations to enable international comparisons to be made.

A.25. Land use data are often collected at the parcel level. A parcel may have more than one land use and, normally, provision is made in the questionnaire for the area of the parcel to be split into more than one land use type. For example, if some fields in a parcel are used for growing temporary crops and others are fallow, the area of temporary crops and fallow land are recorded accordingly.

A.26. Sometimes, there is a mixture of land uses in a parcel or field that cannot be subdivided – for example, where permanent and temporary crops are grown together as associated crops (see paragraph A.109), or where the same land is used for aquaculture in one season and for

growing rice in another season. In such cases, land use should be determined on the basis of its main use. Main use is normally defined on the basis of the value of production from each activity, such as for associated permanent/temporary crops, aquaculture/agriculture, or agriculture/forestry combinations. Where agriculture, aquaculture or forestry activities are carried out on the same land as other activities, the activities related to agriculture, aquaculture or forestry normally take precedence in determining land use.

A.27. Land under temporary crops includes all land used for crops with a less than one year growing cycle; that is, they must be newly sown or planted for further production after the harvest. Some crops that remain in the field for more than one year may also be considered as temporary crops. Asparagus, strawberries, pineapples, bananas and sugar cane, for example, are grown as annual crops in some areas. Such crops should be classified as temporary or permanent according to the custom in the economy.

A.28. The area of land under temporary crops refers to the physical areas of land on which temporary crops are grown (often referred to as net cropped area). The sum of the areas of all temporary crops grown (gross cropped area) may be greater than net cropped area because of successive cropping (see paragraphs A.104– A.105). The comparison between net cropped area and gross cropped area provides the basis for measuring the cultivation intensity. To avoid confusion with other similar terms, viz., gross area and net area used in other FAO publications, the reader is encouraged to refer to paragraphs 35 and 58 of the publication FAO (1982)[22].

A.29. Land under temporary meadows and pastures include land temporarily cultivated with herbaceous forage crops for mowing or pasture. A period of less than five years is used to differentiate between temporary and permanent meadows. If each economy's practice differs from this, the economy's definition should be clearly indicated in census reports.

A.30. Land temporarily fallow is arable land at prolonged rest before re-cultivation. This may be part of the holding's crop rotation system or because the normal crop cannot be planted because of flood damage, lack of water, unavailability of inputs, or other reasons.

A.31. Land is not considered temporarily fallow unless it has been, or is expected to be, kept at rest for at least one agricultural year. If the census is conducted before sowing or planting has been completed, the area lying fallow at that time that will be put under crops soon afterwards should be classified as land under temporary crops, not as fallow land. Fallow land temporarily used for grazing should be classified as "fallow" if the land is normally used for growing temporary crops.

A.32. Land remaining fallow for too long may acquire characteristics requiring it to be reclassified, such as "permanent meadows and pastures" (if used for grazing), "forest or other wooded land" (if overgrown with trees), or "other land" (if it becomes wasteland). A maximum idle period should be specified – five years is usually suitable. Land cultivated on a two- or three-year rotating basis is considered to be fallow if it was not cultivated during the reference year. Land temporarily fallow should be distinguished from land abandoned by shifting cultivation; the former is part of the holding, whereas the latter is not.

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[22] Estimation of Crop Areas and Yields in Agricultural Statistics. FAO, Rome, 1982.

A.33. Land under permanent crops refers to: land cultivated with long-term crops which do not have to be replanted for several years; land under trees and shrubs producing flowers, such as roses and jasmine; and nurseries (except those for forest trees, which should be classified under "forest or other wooded land"). Permanent meadows and pastures are excluded from land under permanent crops.

A.34. Permanent meadows and pastures include land used permanently (for five years or more) to grow herbaceous forage crops, through cultivation or naturally (wild prairie or grazing land).

A.35. Forest and other wooded land is land not classified as mainly "agricultural land" that satisfies either of the following definitions:

- Forest land is land with crown cover of more than 10 percent of trees able to reach a mature height of 5 meters or more. It includes natural and plantation forests. Areas that are temporarily not under trees but are expected to revert to forest are included. Forest tree nurseries that form an integral part of the forest should be included.
- Other wooded land is land with: (i) crown cover of 5–10% for trees able to reach a height of 5 meters or more at maturity; or (ii) crown cover of more than 10% for trees not able to reach a height of 5 meters at maturity; or (iii) shrub or bush cover of more than 10%.

A.36. A clear distinction must be made between "forest and other wooded land" and "land under permanent crops". Plantations of rubber, palm, and other cultivated food tree crops are generally considered to be permanent crops, whereas plantations of bamboo, cork oak, eucalyptus for oil, or any other cultivated non-food tree crops are considered to be forest and other wooded land. However, there may be some special cases, which economies should handle according to domestic conditions and practices. The treatment of borderline cases should be clearly stated in the presentation of census results.

A.37. Other land includes all other land on the holding, not elsewhere classified. It includes uncultivated land producing some kind of utilizable vegetable product, such as reeds or rushes for matting and bedding for livestock, wild berries, or plants and fruit. It also includes land which could be brought into crop production with little more effort in addition to that required in common cultivation practices. Also included under this category is: land used for aquaculture; land occupied by buildings; parks and ornamental gardens; roads or lanes; open spaces needed for storing equipment and products; wasteland; land under water; and any other land not reported under previous classes.

A.38. Based on FAO's recommended land use classification in Figure 11.1, arable land is land that is used in most years for growing temporary crops. It includes land used for growing temporary crops in a twelve month reference period, as well as land that would normally be so used but is lying fallow or has not been sown due to unforeseen circumstances. Arable land does not include land under permanent crops or land that is potentially cultivable but is not normally cultivated. Cropland is the total of arable land and land under permanent crops. Agricultural land is the total of cropland and permanent meadows and pastures.

A.39. Data on area of holding must refer to a point of time, usually the day of enumeration or another day close to it. In determining land use, reference is made to the activities carried out

during a twelve-month or even longer reference period. Usually, the census reference year is used for this purpose. If the land use changed during the year – for example, fruit trees were planted on formerly rice land – the land should be assigned to the present use.

0008 Total Area Of Holding

A.40. Area of holding provides a measure of the size of the holding, which is an important element in the agricultural census analysis. Total area of holding is a derived item, obtained by summing the areas under each of the land use categories (see paragraphs A.20– A.39). Often, land data are collected parcel by parcel and the total area of holding is derived by summing the area of each parcel.

A.41. Total area of holding is the area of all the land making up the agricultural holding. It includes all land operated by the holding without regard to title or legal form. Thus, land owned by members of a household but rented to others should not be included in the area of the holding. Conversely, land not owned by members of a household but rented from others for agricultural production purposes should be included in the holding area. The area of holding may be zero, such as where the holding keeps livestock but has no land; this is called a landless holding.

A.42. The holding's land may consist of one or more land parcels, located in one or more separate areas or in one or more territorial or administrative units, providing the parcels are part of the same economic production unit and share the same production means, such as labor, farm buildings, machinery and draught animals. See paragraph 3.33 for more information on defining holding units when land is located in more than one administrative unit.

A.43. In determining the area of the holding, the following types of land should be included:

- agricultural land, land used for growing temporary crops, land used for permanent crops, meadows and pastures, and fallow land;
- kitchen gardens;
- forest or other wooded land;
- bodies of water owned or in owner-like possession by the holding, regardless of their use;
- other farmyard and land occupied by farm buildings;
- land for which a holding does not have any rights to agricultural use, except for the products of the trees grown on it.

A.44. The following special cases should be noted:

- Where an agricultural holding is operated by a household, the land area of the household’s house should be included, provided the house is located on the holding (and not, for example, in a nearby village or town), and is used solely for residential purposes.
- Where shifting cultivation is present, the area of holding should include the area under crops during the census reference year, and the area prepared for cultivation but not sown or planted at the time of enumeration. Land abandoned prior to the reference period should be excluded.

- Open rangeland, such as land open to communal grazing, is not considered to be part of the holding. For holdings having access to communal grazing land, their share of such land should not be included in the area of the holding unless the holding has been specifically assigned a certain area delimited by fencing or other form of boundary demarcation.
- A body of water owned or in owner-like possession by the holding is included as part of the area of holding, but a body of water that is rented from others for use for aquaculture or other purposes should be not included in the area of the holding.

A.45. Data on area of holding must refer to a point of time, usually the day of enumeration or another day close to it. Where a holder bought land during the census reference year, the area of land bought should be included in the area of the holding; where a holding sold land during the census reference year, the area sold should be excluded.

0009 Land Tenure Types on the Holding

- Legal ownership or legal owner-like possession
- Non-legal ownership or non-legal owner-like possession
- Rented from someone else
- Other types of land tenure

A.46. Item 0009 refers to whether the holding is operated under the specific land tenure types. A holding may have one or more tenure types corresponding to each land parcel. This item is different from earlier agricultural census programs, which provided for data on the area of the holding under each land tenure type – this is now included as supplementary Item 0103.

A.47. Land tenure refers to the arrangements or rights under which the holder operates the land making up the holding. Unlike earlier programs, a distinction is made between legal and non-legal ownership, as this is one of the keys to tenure security. There are many different systems of formal and informal land tenure around the world and the distinction between legal and non-legal ownership is often blurred. Some broad guidelines are given in the following paragraphs, but it is recognized that economies need to define land tenure types according to domestic circumstances.

A.48. Broadly speaking, legal ownership or legal owner-like possession describes land rights that provide statutory security of tenure. Security of tenure has various aspects. Importantly, the ownership must be recognized by the state, and administrative structures must be in place to ensure that property rights are enforceable. This may be done through a formal land title system, but could also include certain forms of customary land tenure arrangements where land rights are registered or certified in some way. Typically, legal ownership implies that the owner of land has the right to determine how the land is used (within certain constraints), and may have the right to sell or rent out the land. It also implies that the owner may access credit using the land as collateral. The following types of tenure arrangements may be included under this heading:

- The holder or members of the holder’s household possess title of ownership, which gives the holder the right to determine the nature and extent of the use of the land.
- The land is held under conditions that enable it to be operated as if legally owned by the holder or members of the holder’s household. A common type of legal owner-like

possession is where land is operated under hereditary tenure, perpetual lease, or long-term lease, with nominal or no rent.

- The land is held under a tribal or traditional form of tenure, which is legally recognized by the state. Such arrangements usually involve land being held on a tribal, village, kindred or clan basis, with land ownership being communal in character but with certain individual rights being held by virtue of membership in the social unit. Such arrangements can be formalized through the establishment of legal procedures to identify the community's land and to manage the land rights of community members.

A.49. Non-legal ownership or non-legal owner-like possession describes a variety of informal land tenure arrangements, which do not provide security of tenure, and where circumstances could arise where the holder may be dispossessed of the land. The following types of tenure arrangements may be included under this heading:

- The holder or members of the holder's household have operated the land without interruption for a long period without any form of legal ownership, title, long-term lease, or payment of rent.
- The land is operated under a system in which a rent-free plot of tribal or other communal land is received and retained as long as it is kept under cultivation by the recipient's personal and household labor, but which cannot be sold or mortgaged.
- The holder is operating land owned by the state, without any legal rights.
- The land operated by the holder is held under a tribal or traditional form of tenure, which is not recognized by the state and outside the realm of the law.

A.50. Rented land from someone else means land that is rented or leased by the holding from other persons, usually for a limited time period. Rental arrangements can take different forms. Land may be rented for an agreed sum of money and/or produce, for a share of the produce, or in exchange for services. Land may also be granted rent free. For more information on different rental conditions, see paragraph A.59.

A.51. There are various other types of land tenure. One example is land operated on a squatter basis; that is private or public land operated without ownership title and without the owner's consent. Other land tenure types include: land operated under transitory tenure forms, such as trusteeship; land received by members of collective holdings for individual use; and land under inheritance proceedings. Economies may add further classes to suit local conditions.

A.52. Land tenure refers to the current status of the land operated by the holding. The collection of data should relate specifically to that land. Land rented out to others should be excluded. The reference period for land tenure data is usually the day of enumeration.

3.1.2 Supplementary items

0101 Location (for each parcel)

A.53. For the purposes of the agricultural census, a holding is divided into parcels, where a parcel is any piece of land, of one land tenure type, entirely surrounded by other land, water, road, forest or other features not forming part of the holding or forming part of the holding under a different land tenure type. A parcel may consist of one or more fields or plots

adjacent to each other. The concept of a parcel used in the agricultural census may not be consistent with that used in cadastral work. The reference period is a point of time, usually the day of enumeration.

A.54. A distinction should be made between a parcel, a field and a plot. A field is a piece of land in a parcel separated from the rest of the parcel by easily recognizable demarcation lines, such as paths, cadastral boundaries and/or hedges. A field may consist of one or more plots, where a plot is a part or whole of a field on which a specific crop or crop mixture is cultivated.

A.55. The location of the parcel is important when disaggregating land data by administrative units. In an agricultural census, the location of a holding is usually identified by where the farm buildings or agricultural machinery are located (see paragraph A.4). If the location of each parcel is not identified, all parcels would be assigned to the location of the holding, which could lead to inconsistencies with data from other sources. The location of the parcel refers to the administrative unit in which the parcel is located. For more on collecting location data, see paragraphs A.5 & A.6.

0102 Area (for each parcel)

A.56. For the definition of a parcel, see paragraphs A.53– A.54. For information on how to determine the area of holding, see paragraphs A.40– A.45. Note that the sum of the parcel areas must be equal to the total area of the holding.

0103 Land Tenure (for each parcel)

- Legal ownership or legal owner-like possession.
- Non-legal ownership or legal owner-like possession.
- Rented from someone else.
- Other types of land tenure.

A.57. “Land tenure types” was included as Item 0009 in the list of recommended core census items to provide data on whether the holding had the specified land tenure types. Item 0103, land tenure, refers to the tenure type of each parcel. This information can be used in conjunction with the parcel area to estimate the area under different land tenure types.

A.58. Note that a parcel must be of one tenure type (see paragraph A.53). Refer to paragraphs A.46 – A.52 for definitions of land tenure and a description of the different land tenure types. The reference period is usually the day of enumeration.

0104 Terms of Rental (for each parcel)

- For an agreed amount of money and/or produce
- For a share of produce
- In exchange for services
- Under other rental arrangements

A.59. This item relates to the conditions under which land is rented from others. It applies to parcels “rented from someone else” in Item 0103, and refers to the current rental arrangements. Rental arrangements may take different forms.

- Land rented for an agreed sum of money and/or produce is usually the result of a straightforward transaction between the owner of the land and the holder, who takes responsibility for managing and operating the land.
- Share of the produce (crop production), or in exceptional cases an equivalent in money, covers the situation where a share amount is agreed upon by the owner and the holder depending on local conditions and the type of agriculture involved. Technical responsibility for management is usually exclusively with the holder, but is sometimes shared, to a limited degree, with the owner. Here, the owner may contribute tools, fertilizers or other aids, and may also share the economic risks.
- Exchange for services refers to where the holder is granted use of the land in return for services. Often, it is in lieu of wages, such as where an agricultural laborer operates a piece of land in return for which he/she must work, unpaid, for the landlord for a certain number of days. Another example is where a holder is granted use of land in partial payment for services to government, religious organization or other institution.
- Other rental arrangements include land granted rent free, perhaps under stipulated conditions such as growing certain crops.

0105 Presence of Shifting Cultivation (for each parcel)

A.60. Shifting cultivation is a farming practice whereby a particular piece of land is cultivated for some years and then abandoned for a period sufficient to restore its fertility by natural vegetative growth before being re-cultivated. Often, fertilizers are not used. As a result, the productivity of the cultivated land quickly deteriorates and the land is abandoned because it becomes economically unviable to continue cultivating the land. Abandoned land usually takes a long time to regain fertility by natural processes. Sometimes, farmers cultivate the land on a rotating basis. Some holders move their dwellings when they shift to new land; others do not. Shifting cultivation is also known as “slash-and-burn cultivation”.

A.61. Data are collected in respect of land cultivated using shifting cultivation methods during a twelve month period, usually the census reference period.

0106 Number of Years Since Cleared (for each parcel)

A.62. The purpose of this item is to better understand the extent of recent land clearances, especially where shifting cultivation is present or where deforestation is a concern. Usually, it will only be necessary to collect data in broad ranges, such as: in the last one year; 1–3 years ago; 4 or more years ago.

A.63. Where different parts of the parcel are cleared at different times, the time when most of the land was cleared should be reported. If land is re-cleared after being left uncultivated for a long time, the most recent land clearance should be taken.

0111 Presence of Soil Degradation: Type and Degree (for the holding)

- Soil erosion (none/light/moderate/severe)
- Chemical degradation (none/light/moderate/severe)
- Physical degradation (none/light/moderate/severe)

A.64. Soil degradation is the decline in soil quality caused by natural processes or, more commonly, improper use by humans. Its consequences include: loss of organic matter; decline in soil fertility; decline in structural condition; erosion; adverse changes in salinity, acidity or alkalinity; and the effects of toxic chemicals, pollutants or excessive flooding.

A.65. Three categories of soil degradation are shown. Soil erosion is the displacement of soil material by running water, rainfall, wind or other factors, resulting in a decline of arable layers. Chemical degradation refers to deterioration in the chemical make-up of the soil because of loss of nutrients and/or organic matters, calcification, acidification or pollution. Physical degradation refers to the physical deterioration of the soil, such as compaction, crusting and sealing, water-logging, and subsidence.

11.66. Degree refers to the extent of the particular type of degradation, as follows:

- None: there is no degradation of the given type on the holding.
- Light: the productivity of the land on the holding is slightly reduced but restoration would be possible with modifications in the farm management system.
- Moderate: the productivity of some of the holding's land is considerably reduced, and substantial improvements would be needed to restore full agricultural potential.
- Severe: most of the holding's land is so badly degraded that it cannot be recovered and agricultural production is no longer possible in much of the holding. "Desertification" is one type of severely degraded land.

11.67. The intention of Item 0111 is not to get a technical assessment of the state of the holding's land, but to get the holder's overall impressions of the extent to which land degradation is present on the holding and the effect it is having on agricultural output. It is usually not worthwhile collecting these data parcel by parcel; a broad assessment for the holding as a whole is usually sufficient. Collecting soil degradation data can be difficult, and questionnaires need to be carefully designed. Specific questions may need to be asked about the most common types of soil degradation, and enumeration aids provided to help enumerators assess the extent of the degradation. The reference period for soil degradation data is usually the day of enumeration.

3.2 THEME 02: IRRIGATION AND WATER MANAGEMENT

3.2.1 Core Items

0010 Presence of Irrigation on the Holding

A.68. Item 0010 is recommended for inclusion in the core module to provide a sampling frame for the census supplementary irrigation survey and for other irrigation surveys. This item also helps to better understand cropping practices and the constraints on improving agricultural productivity.

A.69. Irrigation refers to purposely providing land with water, other than rain, for improving pastures or crop production. Irrigation usually implies the existence of infrastructure and equipment for applying water to crops, such as irrigation canals, pumps, sprinklers or localized watering systems. However, it also includes manual watering of plants using buckets, watering cans or other devices. Uncontrolled land flooding by overflowing of rivers or streams is not considered irrigation.

A.70. Irrigation includes any process under which water is moved from a water source to apply to an agricultural crop. Water for irrigation may come from various sources, including rivers, dams or wells. The irrigation water may be the product of a major irrigation scheme serving many farmers over a large area, or a local scheme serving a small community. Farmers may also carry out irrigation individually using informal arrangements to obtain water from rivers, streams, wells or ponds, using equipment such as a pump or manual methods such as buckets. In urban and semi-urban areas, irrigation may be carried out with hoses and buckets, sometimes using the municipal water supply.

A.71. Irrigation implies the "fully controlled" supply of water, as opposed to other types of water management where the availability of water depends on rainfall conditions. Water management activities such as controlling flood waters to water crops (spate irrigation), water control methods in wetland areas, and flood recession cultivation should not be included as irrigation. These types of activities are covered in Item 0206 in the supplementary component. The use of water from water harvesting facilities, such as roof water harvesting, may be included as irrigation if the water supply is reliable.

A.72. Item 0010 refers to whether irrigation took place on the holding during a twelve-month reference period, usually the census reference period. The item relates to the actual use of irrigation, not to whether the holding is equipped for irrigation. The infrastructure for irrigation may exist on a holding – that is, irrigation facilities such as canals and sprinkler systems are available – but these facilities may not actually be used by the holding during the reference year because of water shortages, lack of fuel, or inability to pay water fees. Irrigation refers to whether water was provided, regardless of whether the quantity of water was sufficient.

3.2.2 Supplementary Items

0201 Area of Land Irrigated According to Land Use Type (for the holding)

- Land under permanent crops

- Land under temporary crops
    - Single-irrigated crop
    - Multiple-irrigated crops

A.73. See paragraphs A.69– A.72 for the definition of land irrigated. See paragraph A.33 for the definition of land under permanent crops and paragraphs A.27 & 11.28 for the definition of land under temporary crops.

A.74. Note that area irrigated in Item 0201 refers to the physical area of land irrigated, not the total area of crops irrigated. Thus, land irrigated for successive crops in different seasons within the reference year is only counted once in computing the area of land irrigated, and shown under multiple-irrigated crops. Land under temporary crops with single-irrigated crop refers to land with a single irrigated crop during the reference year, or land with successive crops with irrigation being used for only one of the crops during the reference year.

A.75. Item 0201 is a holding level item. However, for operational reasons, economies may find it easier to collect the data at the parcel level and aggregate up to the holding level. Economies may wish to include this item in the core module if a supplementary irrigation module is not conducted.

0202 Area Irrigated According to Method of Irrigation (for the holding)

- Surface irrigation
- Sprinklers
- Localized irrigation

A.76. See paragraphs A.73 & 11.74 for more information on land irrigated.

A.77. Surface irrigation refers to a system for partially or completely covering land with water for the purpose of irrigation. There are various types including furrow, border-strip and basin irrigation. Basin irrigation includes submersion irrigation for rice.

A.78. Sprinkler irrigation refers to pipe networks through which water moves under pressure before being delivered to the crop via sprinkler nozzles. The system basically simulates rainfall in that water is applied through overhead spraying. Sprinkler irrigation systems are sometimes known as overhead irrigation systems.

A.79. Localized irrigation is a system where the water is distributed under low pressure through a piped network, in a pre-determined pattern, and applied as a small discharge to each plant. There are several types: drip irrigation (where drip emitters apply water slowly to the soil surface), spray or micro-sprinkler irrigation (where water is sprayed to the soil near individual plants or trees), and bubbler irrigation (where a small stream is applied to flood small basins or the soil adjacent to individual trees). Other terms commonly used to refer to localized irrigation are micro-irrigation, trickle irrigation, daily flow irrigation, drip-irrigation, sip irrigation, and diurnal irrigation.

0203 Area Irrigated for Each Crop Type (for the holding)

A.80. Item 0203 refers to the area of crops irrigated, as opposed to the area of land irrigated given in Items 0201 and 0202 (see paragraph A.74). For example, a plot of 0.4 ha with crops irrigated in two seasons within the reference year is recorded as 0.4 ha of land irrigated in

Item 0201, and 0.8 ha of crops irrigated in Item 0203. Analysis of the crop area irrigated in relation to the land irrigated provides information on cropping intensity under irrigation.

A.81. For temporary crops, Item 0203 refers to that portion of the harvested area (see paragraphs A.99– A.111) irrigated during the reference year. For permanent crops, Item 0203 refers to that portion of the area of permanent crops on the day of enumeration (see paragraph A.118) irrigated at some time during the reference period. See paragraphs A.73 & A.74 for the definition of irrigation.

0204 Sources of Irrigation Water (for the holding)

- River/lake/pond (by gravity)
- River/lake/pond (pumping)
- Dam/reservoir
- Deep well/tube well
- Shallow well
- Municipal water supply
- Treated waste water
- Desalinated water
- Other

A.82. Item 0204 refers to whether irrigation water used on the holding was obtained from the given sources. A holding may obtain water from more than one source. The reference period is the census reference year. See paragraphs A.73 & A.74 for the definition of irrigation.

A.83. Usually, source of irrigation water refers to the original source of the water. Thus, if a canal network is used to distribute water from a dam to farmers, the source of the water is the dam, not the canal. Economies may need to adapt the classes given to meet their needs.

0205 Payment Terms for Irrigation Water (for the holding)

- Did not pay for water
- Paid for water
    - Fee per area
    - Fee per volume
    - Other

A.84. This item refers to whether payment was made for the irrigation water used on the holding. If payment is made in more than one way – such as both on an area and volume basis – it should be assigned to the “other” category. The reference period is the census reference year. See paragraphs A.73 & A.74 for the definition of irrigation.

0206 Other Types of Water Management Practices (for the holding)

- Wetland and inland valley bottoms
- Flood recession cultivation
- Spate irrigation
- Other

A.85. Item 0206 refers to whether specific water management practices, other than irrigation, were used on the holding. See paragraph A.71 for more on the differences between irrigation and water management. A holding may have more than one type of water management activity. Data on water management are normally collected in respect of a twelve-month

reference period, but data may be distorted by unusual weather conditions in the reference year; for example, if there is no flood recession cultivation because of low flood levels. A longer reference period, such as a three-year period, may be considered for some economies.

A.86. Wetland and inland valley bottoms are lowland areas subject to seasonal flooding, that are used for cropping when covered with water. Water control structures, such as canals, may be constructed to help in the crop cultivation.

A.87. Flood recession refers to areas along the edge of rivers or other water bodies where cultivation occurs, making use of water from receding floods. Floating rice is included as a flood recession crop. Structures may be built to retain the receding water.

A.88. Spate irrigation is a method of random irrigation using the floodwaters of a normally dry water course or riverbed (wadi). Spate irrigation is also referred to as floodwater harvesting. There are two types of spate irrigation. One is where floodwater is harvested in streambeds and spread through the wadi in which the crops are planted. Cross-wadi dams are constructed with stones or earth, often reinforced with gabions. A second type is where floodwater is diverted from the seasonal rivers into adjacent embanked fields for direct application. Here, a stone or concrete structure raises the water level within the wadi to enable it to be diverted.

0207 Presence of Drainage Equipment (for the holding)

A.89. For the purpose of the agricultural census, drainage is the artificial removal of excess surface water or groundwater, together with dissolved substances, from the land surface by means of surface or subsurface conduits, to enhance agricultural production. It does not include natural drainage of excess water into lakes, swamps and rivers.

A.90. Presence of drainage equipment means that the equipment is present on the holding at a point of time, such as the day of enumeration. There are different types of drainage facilities. Surface drains divert excess surface water away from an agricultural area to prevent inundation. Sub-surface drains allow excess water and dissolved substances to flow through the soil to open wells, moles, pipe drains and/or open drains. On irrigated land, drainage may control salinity or water-logging. Management of water for flood recession cropping is considered water management (Item 0206), not drainage.

3.3 THEME 03: CROPS

3.3.1 Core Items

0011 Types of Temporary Crops on the Holding

A.91. Past agricultural census programs included an item on the area of each temporary crop harvested. In WCA 2010, information on temporary crops for the core module is limited to whether the holding grew each specific type of crop, as provided in Item 0011. This item is useful for sampling frames for census supplementary modules and other crop surveys. It is proposed that area data for temporary crops be collected in the crop supplementary module as Item 0301. Some economies may want to include crop area data in the core census module, especially to provide benchmarks for current crop production statistics.

A.92. Temporary crops are those with a less than one year growing cycle (see paragraphs A.27 & A.28). Some economies may wish to include only the major crops; however, it should be borne in mind that, because it is based on complete enumeration, the core census module may provide the only means of getting reliable data for the minor crops.

A.93. A crop classification is shown in Appendix 3[23] to help in collecting and tabulating crop data. An alphabetical list of crop names is also given in Appendix 4 (FAO. 2005). The crop classification is not exhaustive and all crops listed do not apply to any one economy. Economies should expand or abridge the crop list, taking into account the importance of specific crops in each economy. For a dominant crop, an economy may wish to provide further detail, such as by season (for example, summer/winter or wet/dry seasons), land type (for example, lowland/upland), or variety (for example, local/improved). Economies may also wish to disaggregate data by end-use, such as whether it is to be used for food or animal feed. Refer to Appendix 3 (FAO.2005) for more information on the principles underlying the crop classification and the problems in providing further detail.

A.94. Data on temporary crops are collected in respect of a twelve-month reference period to reflect crops grown in all seasons of the year. The agricultural year is usually the most suitable reference period because enumerators and farmers can usually easily relate to that period in reporting crop data. Crops are normally reported according to the year in which they are harvested (see paragraphs A.102– A.103).

0012 Types of Permanent Crops on the Holding and Whether in Compact Plantations

A.95. Past agricultural census programs included data on the area and number of trees for each permanent crop. In WCA 2010, information on permanent crops for the core module is limited to whether each specific type of crop is present on the holding, and which crops are grown in a compact plantation. This is provided in Item 0012. This item is useful for sampling frames for census supplementary modules and other crop surveys. It is proposed that more detailed data on permanent crops be collected in the crop supplementary module as

[23] A system of integrated agricultural censuses and surveys - Volume 1 World Programme for the Census of Agriculture 2010, FAO Statistical Development Series 11, Rome, 2005.

Items 0311–0314. Some economies may wish to include some more detailed data in the core census module.

A.96. Permanent crops are crops with a more than one year growing cycle (see paragraph A.33). Permanent crops may be grown in a compact plantation or as scattered trees/plants and both should be included. A compact plantation includes plants, trees and shrubs planted in a regular and systematic manner, such as in an orchard. Plants, trees or shrubs forming an irregular pattern but dense enough to be considered as an orchard, are also considered a compact plantation.

A.97. Economies should refer to Appendices 3 and 4 for a list of crops. Economies should expand or abridge the crop list, taking into account their circumstances and data needs (see paragraph A.93).

A.98. For permanent crops, data are collected in respect of a single point of time, usually the day of enumeration. Thus, a permanent crop is included if it is present on the holding on the day of enumeration.

3.3.2 Supplementary Items

0301 Area of Temporary Crops Harvested (for each temporary crop type)

A.99. Temporary crops are crops with a less than one-year growing cycle (see paragraphs A.27 & A.28). For help in identifying crops, refer to the crop classification in Appendix 3 and the alphabetical list of crops in Appendix 4. See also paragraph A.93. The reference period for data on the area of temporary crops is the census reference year or the agricultural year.

A.100. Area harvested refers to the total area from which the crop is gathered. Thus, area destroyed because of drought, flooding, pest attack or any other reason is excluded. In this regard, a certain percentage loss criterion – for example, yield is less than 20% of what it normally is – is used to determine if a crop is destroyed. Crop that is damaged but not destroyed is included in the area harvested. If possible, the area harvested should exclude uncultivated patches, footpaths, ditches, headlands, shoulders and shelterbelts.

A.101. Area harvested only covers crops grown to maturity. It does not include nurseries, where plant propagation materials are produced for sale or use on the holding (see paragraphs A.144 & A.145). If, for example, rice seedlings are grown for transplanting on the holding, the nursery area of the seedlings is not included in the area harvested, but the harvest from the transplanted seedlings is included. Area harvested includes all crop harvested regardless of its end-use; thus, area harvested includes crop harvested for human consumption, for animal feed, or for any other reason. Crops grown to maturity for harvesting specifically for the production of seed (“seed fields”) should be included.

A.102. Usually, it is easy to assign crops to the reference year. However, a crop may be planted in one agricultural year and harvested in the next agricultural year. Sometimes, the crop season extends over a long period, with the result that part of the crop is harvested in one agricultural year and the rest in the next agricultural year. Problems also occur where the seasons differ in different areas of the economy and, for example, a particular seasonal crop

grows late in the agricultural year in one area and early in the following agricultural year in another area.

A.103. The recommended approach is to identify crops covered by the census according to whether they are harvested during the reference year, with special exceptions made for end-of year crops. An alternative approach used by some economies is to identify a crop according to the season in which it grows, rather than referring specifically to the agricultural year. Depending on the treatment of end-of-year crops and the timing of the data collection, some crops may not yet be harvested at the time of the census, and data on "expected area harvested" should be reported.

A.104. Temporary crops may be grown more than once on the same land in the same agricultural year. This is known as successive crops. This may involve the same crop or different crops and is important in economies with more than one cropping season. For successive crops, the area should be reported for each crop each time the land is sown during the year. Thus, if a 1 ha field is used for growing rice in the summer and maize in the winter, the crop area data are shown as 1 ha of rice and 1 ha of maize. If two rice crops – a summer crop and a winter crop – are grown on the 1 ha field during the year, the area of rice is shown as 2 ha. Successive crops may be grown by two different holdings and should be counted accordingly.

A.105. Successive crops should be distinguished from successive harvests of the same standing crop, such as for sugar cane or hay, where the area should be counted once only. The same applies where the same crop produces more than one product during the agricultural year, such as cotton producing both fiber and seed. Here, the area harvested should be reported under the principal product.

A.106. A plot or field in which one crop is planted between rows of another crop – for example, sorghum and groundnuts between cotton rows – is referred to as having inter-planted crops. Here, the area of the inter-planted plot or field is assigned to individual crops in proportion to the area occupied by each crop. The sum of the areas of the individual inter-planted crops must be equal to the area of the plot or field.

A.107. The same applies to mixed crops, where more than one (often many) crops are grown unsystematically in a plot or field. Here, it is more difficult to calculate areas and some estimation is needed. This may be based on quantities of seed used for crops in the mixture, plant density in the crop mixture, eye estimates of the proportions of area occupied by the component crops, or the number of plants per area unit. The sum of the areas of the individual mixed crops must be equal to the area of the plot or field.

A.108. Sometimes, economies may wish to report a crop mixture or inter-planting as a single crop unit, rather than as individual crops, because it is an important production system. Sometimes, crops are specifically grown as a mixture, especially grains, and it can be difficult to apportion the area to the individual crops. Economies may treat such cases as a single crop under a suitable crop title, such as "mixed cereals for grain". It is recommended that, where possible, the area of such crop mixtures should also be sub-divided into their component crops to enable international comparisons to be made. Often, there are standard crop mixtures, which can help in this regard.

A.109. A temporary crop grown in a compact plantation of permanent crops – a so-called associated crop – should be distinguished from a mixed crop. Normally, the area of the temporary crop is estimated by apportioning the land in a suitable manner. See paragraph A.121 for more information.

A.110. Sometimes, temporary crops are grown scattered around the holding and it is difficult to measure the area. Some estimation is usually possible where the crops are grown in some sort of systematic manner, such as on the bunds of a paddy field. If the crop is not planted systematically or sufficiently densely to permit the area to be measured, the crops are often omitted. Sometimes, economies impose a minimum size criterion for the collection of area data – for example, 100 square meters.

A.111. Normally, an agricultural census collects data on the area of crops harvested, not the area planted. However, it is recognized that some economies may also wish to collect data on area planted to assess crop loss.

0302 Area of Temporary Crops Harvested According to End-Use (for each selected crop type)

A.112. End-use is a new concept in WCA 2010, and has been introduced to help assess food supplies and the production of fodder crops.

A.113. End-use refers to what the crop is used for. Crops may be grown for use as food for human consumption, as feed for animals, or for non-food products such as tobacco and flowers. A single crop may have more than one use, such as maize being grown partly for human consumption and partly as a fodder crop. Some economies may be interested in the type of product obtained from a crop, such as whether chilies are harvested for use as fresh or dried produce, or whether cotton is harvested for fiber or seeds. Other economies may wish to identify crops used for industrial purposes. The reference period should be consistent with Item 0301, usually the census reference year.

A.114. Economies should collect end-use data according to domestic conditions and data requirements, focusing on crops with multiple uses. As a minimum, the following end-use types should be identified:

- Food for human consumption
- Feed for animals
- Other uses

0303 Production of Temporary Crops Harvested (for each selected crop type)

A.115. In the past, agricultural censuses did not normally include a crop production item because it was not considered to be structural data. In the 2010 round of agricultural censuses, it is recommended that production for selected crops be collected in the crop supplementary module. Economies should choose the crops according to their needs. Production data in an agricultural census are useful as benchmarks for current crop production statistics.

A.116. Production refers to the actual quantity of produce, after drying and processing ready for sale or consumption, and after deducting pre-harvest, harvest and post-harvest losses (FAO, 1982, paragraphs 61–68). The reference period should be consistent with Item 0301, usually the census reference year.

0311 Area of Productive and Non-Productive Permanent Crops in Compact Plantations (for each permanent crop type)

A.117. Permanent crops are crops with a more than one-year growing cycle (see paragraph A.33). For help in identifying crops, see Appendices 3 and 4. For the definition of a compact plantation, see paragraph A.96.

A.118. Area of permanent crops refers to the area of the crop at a single point of time, usually the day of enumeration. Permanent crops should only be included if they are grown for the purpose of producing crops. It does not include nurseries, where plant propagation materials are produced for sale or use on the holding (see paragraphs A.144 & A.145).

A.119. Permanent crops of productive age refer to permanent crops already bearing fruit or otherwise productive. Most tree crops and some other permanent crops become productive after a certain age. Crops at that stage should be enumerated as "of productive age" even if, due to weather or other reasons, they did not yield a harvest in the most recent season. Senile or other trees of productive age, but no longer productive, should not be considered as productive.

A.120. Two or more permanent crops grown together in a compact plantation should be treated in the same way as inter-planted or mixed temporary crops (see paragraphs A.106–A.108).

A.121. Special procedures are needed to measure area where permanent crops are grown in a compact plantation in association with temporary crops (see also paragraph A.109). If the density of trees/plants for the permanent crop is not affected by the presence of the temporary crops, the area of permanent crops is normally measured as the whole area of the compact plantation. This is a common situation, especially where temporary crops are grown between the rows of existing trees/plants. Sometimes, this can even be to the benefit of the permanent crop. Thus, for example, a 1 ha compact plantation of coffee grown in association with vegetables would be measured as 1 ha of coffee and, say, 0.5 ha of vegetables. In other words, the total area of the associated crops is greater than the physical area of the piece of land. This is quite different from the treatment of inter-planted or mixed crops (see paragraphs A.106–A.108). Often, the association of temporary and permanent crops is quite complex, with several permanent and temporary crops growing together in the one compact plantation. Economies will need to develop procedures suitable for domestic circumstances.

0312 Number of Permanent Crop Trees in Compact Plantations and Scattered Plantings (for each tree crop)

A.122. Item 0312 refers to the number of trees for scattered permanent crops for tree crops. Tree crops are defined as permanent crops in Group 3, Class 44 or Class 94 of the crop classification (see Appendix 3, FAO, 2005). Economies may wish to include other permanent crops if suitable. As with all data on permanent crops, the reference period is the day of enumeration. Nurseries are excluded (see paragraphs A.144 & A.145).

A.123. For the definition of permanent crops, see paragraph A.33. For help in identifying crops, see Appendices 3 and 4. For the definition of a compact plantation, see paragraph A.96. Scattered plants are those planted in such a manner that it is not possible to estimate the area. Often, they are scattered around the holding.

0313 Area of Productive Permanent Crops in Compact Plantations According to End-Use (for each selected permanent crop type)

A.124. End-use is a new item in WCA 2010. End-use refers to what the crop is used for (see paragraph A.113). Economies should collect end-use data specific to their domestic conditions and data requirements, focusing on those crops with multiple uses. As a minimum, the following end-use types should be identified:

- Food for human consumption
- Feed for animals
- Other uses

A.125. For the definition of permanent crops, see paragraph A.33. For the definition of a compact plantation, see paragraph 11.96. For information on area of permanent crops, see paragraph A.118. For the definition of productive permanent crops, see paragraph 11.119. The reference period is the day of enumeration.

0314 Production of Permanent Crops (for each selected permanent crop type)

A.126. See paragraph 11.115 for information on production data in the agricultural census. Production refers to the actual quantity of produce, ready for sale or consumption (see paragraph A.116). The reference period is the census reference year.

0321 Area of Land Used to Grow Temporary Crops as A Secondary Land Use (for the holding)

A.127. Most temporary crops are grown on land classed as having main use "land under temporary crops" in the land use classification (see paragraph A.27). However, temporary crops can also be grown on other land use types. They may be grown in association with permanent crops on land classed as "land under permanent crops", or grown on land classed as "forest and other wooded land". Also, land mainly used for aquaculture may be cropped during part of the year.

A.128. To get a complete picture of temporary crops, it is necessary to find out about land used for growing temporary crops as a secondary land use. For associated crops and crops grown in forest and other wooded land, the proportion of the parcel/field/plot used for temporary crops needs to be estimated – see paragraphs A.109 and A.121. Where a piece of land has a primary use which enables it to be cropped for part of the year, such as for aquaculture, the area cropped should be reported.

A.129. This item relates to land as measured in the land use classification; namely, the area on the day of enumeration according to its main use during the census reference year. Secondary land use relates to secondary activities on the land during the census reference year.

0322 Use of Each Type of Fertilizer (for the holding)

- Fertilizer
  - — Mineral fertilizers
  - — Organo-mineral fertilizers
  - — Organic fertilizers
  - — Bio-fertilizers
- Other organic materials to enhance plant growth

A.130. For the purposes of the agricultural census, fertilizers are mineral or organic substances, natural or manufactured, which are applied to soil, irrigation water or a hydroponic medium, to supply plants with nutrients or to enhance plant growth. The term "fertilizer" normally applies to sources of plant nutrients which contain at least 5 percent of a combination of the three primary nutrients (N, P2O5 and K20). Products with less than 5 percent of combined plant nutrients should be shown under the heading other organic materials to enhance plant growth. A holding may use one or more type of fertilizer.

A.131. Fertilizer usage data usually refer to a twelve-month period, usually the census reference year.

A.132. Mineral fertilizers are fertilizers prepared from inorganic materials manufactured through an industrial process. Manufacturing entails mechanical enrichment, simple crushing, or more elaborate chemical transformation of one or more raw materials. Mineral fertilizers are also known as "chemical fertilizers", "artificial fertilizers", and "inorganic fertilizers".

A.133. Organo-mineral fertilizers are materials obtained through blending or processing organic materials with mineral fertilizers to enhance their nutrient content and fertilizing value.

A.134. Organic fertilizers are fertilizers prepared from processed plant or animal material and/or unprocessed mineral materials (such as lime, rock or phosphate) containing at least 5% of combined plant nutrients. Organic fertilizers include some organic materials of animal origin, such as guano, bone meal, fish meal, leather meal and blood. Other organic materials such as manure, slurry, compost and sewage sludge contain less than the required nutrient content and should be considered as "other organic materials to enhance plant growth".

A.135. Bio-fertilizers are products containing living or dormant micro-organisms, such as bacteria and fungi, which provide nutrients to enhance plant growth.

A.136. Other organic materials to enhance plant growth are any materials other than fertilizers that are applied to the soil to correct low nutrient content or any other problem. This includes manure, slurry, compost and sewage sludge, lime, gypsum, sawdust, crop residue and synthetic soil conditioners. These materials may be of widely varying compositions, including farmyard manure, liquid or semi-liquid manure, straw, compost, green manure and peat. The organic materials may contain fertilizer elements, but they are also applied to improve soil properties, such as soil structure and porosity, water-holding capacity, aeration, and temperature control.

A.137. The term manure is usually used in the sense of farmyard or animal manure, which is a mixture of solid excreta of animals with litter used for their bedding. Slurry is a mixture of liquid and solid animal excreta, with or without dilution with water. Compost consists of organic materials of animal, plant or human origin partially decomposed through fermentation. Sewage sludge is residual organic material derived from sewage. The term green manure describes fresh plant material which is locally produced and is worked into the soil without composting or digestion through animals.

0323 Area Fertilized for Each Type of Fertilizer and Major Crop Type (for the holding)

A.138. This item refers to the area of crops fertilized, according to the definition of fertilizers in Item 0322. For temporary crops, the area fertilized refers to that part of the area harvested to which fertilizers were applied some time during the census reference year. For permanent crops, the area fertilized refers to that part of the current area of permanent crops fertilized some time during the census reference year. The area of a crop fertilized may be all or part of the total area of the crop. Note that this item relates to the crops fertilized, not the land fertilized; thus, if fertilizer is used on two crops grown successively on the same land in two seasons, the fertilized area should be counted twice. Economies will wish to limit this item to the most important domestic crops.

0324 Source of Seed Inputs for Each Major Crop Type (for the holding)

- Self-production
- Exchanges within community
- Local market
- Seed company
- Donation

A.139. This item refers how seeds were acquired. For the purpose of the agricultural census, seeds refer to any planting material, including seeds themselves, seedlings, cuttings, and small plants or trees. The reference period is the census reference year. There may be one or more sources of seeds for a given crop. Economies should limit this item to the most important domestic crops.

A.140. Self-production refers to seeds obtained by setting aside a portion of the previous year's crop for use as seed for the current crop. Exchanges within community are seeds obtained through loans, gifts, or other forms of reciprocal assistance, including seed-for-seed exchanges between farmers. Local market refers to the purchase of seed, either for cash or in exchange for other commodities, through markets, itinerant traders or localized trade networks. Seed company refers to seed purchased from a seed producer or supplier through a commercial arrangement. Donation refers to donations of seed from domestic or international institutions.

0325 Type of Seed for Each Major Crop Type (for the holding)

- Certified seed of modern variety
- Uncertified seed of modern variety
- Uncertified seed of farmers' variety
- Other

A.141. This item refers to whether the seed used has been certified according to the domestic certification system and whether it belongs to a modern or farmer's variety. For more information on seeds, refer to paragraph A.139. The reference period is the census reference year.

A.142. Certified seeds are those that can be certified as meeting certain domestic standards as regards their physical and genetic purity. Seed certification systems vary between economies. Some economies have a self-regulatory system in the seed production industry. In other economies, a government regulatory agency is responsible for controlling the seed production process and certifying that seed is of acceptable standard. Usually certified seeds are labeled

in some way. For the agricultural census, seeds should be shown as "certified" only if the seed used during the reference year was purchased from the market as certified seed or otherwise received as certified seed. Only newly acquired certified seed should be included; seed collected from a crop that had been planted with certified seeds in a previous year should not be considered as certified.

A.143. Uncertified seed refers to seed that is not certified according to the domestic standards. These are often provided through the informal sector. Modern varieties are the products of plant breeding in the formal system by professional plant breeders. These varieties are also called "high-yielding varieties" or "high-response varieties". Economies with a system of registration and release of cultivated varieties develop lists or catalogues of released modern varieties, which can be used for the collection of these data in the agricultural census. Farmers' varieties, also known as landraces or traditional varieties, are the product of breeding or selection carried out by farmers, either deliberately or not, continuously over many generations. These varieties are clearly identified by farmers.

0326 Area of Nurseries (for the holding)

A.144. A nursery is an area where young plants, trees or vines are propagated for the purpose of transplanting. Plants in a nursery are not harvested and are therefore not included in the area harvested (temporary crops in Item 0301) or current area (permanent crops in Item 0311). A nursery might be in the open or under protective cover. It may be used for the development of planting materials for the holding itself or for sale. Nurseries do not include seed fields (see paragraph A.101).

A.145. This item refers to the area of land used for nurseries, not the total area of the nursery crops. Thus, a piece of land used during the year for nurseries for two crops should be counted only once. The reference period is the census reference year.

0327 Area of Cropped Land Under Protective Cover (for the holding)

A.146. Cropped land under protective cover is land under permanent structures with a roof of glass, plastic or other material used for protecting crops against the weather, pests or diseases. Such structures may be used for growing temporary or permanent crops. Typical crops grown are vegetables, herbs and flowers. Structures to provide protection against the weather are known as "greenhouses". Temporary devices for short-term protection, such as plastic covering to protect against frosts, should not be included. Netting to protect against insects or other animals should also be excluded. Nurseries should also be excluded.

A.147. The data relate to the presence, on the day of enumeration, of protective structures that were used for growing crops during the census reference year.

3.4 THEME 04: LIVESTOCK

3.4.1 Core Items

0013 Number of Animals on the Holding for Each Livestock Type

A.148. The number of livestock is one of the fundamental items in the core module of the agricultural census, and is especially useful as a means of providing sampling frames for livestock surveys.

A.149. Livestock refers to all animals, birds and insects kept or reared in captivity mainly for agricultural purposes. This includes cattle, buffaloes, sheep, goats and pigs, as well as poultry, bees and silkworms. Domestic animals, such as cats and dogs, are excluded unless they are being raised for food or other agricultural purposes.

A.150. This item should cover all livestock of any type being raised on the holding. Reference should be made to the list of livestock types given in Appendix 5 (FAO. 2005). Sometimes, an economy may wish to sub-divide an important livestock type by breed or raising method; for example, chickens may be split into local and imported breeds, or sub-divided according to whether they are raised by "free-range" or commercial methods. Some economies may wish to include only the major livestock types in the census core module, but should bear in mind that, because it is based on complete enumeration, the core module may provide the only means to get reliable data on minor livestock types.

A.151. The number of animals is the animal population on the holding at a specific point of time, usually the day of enumeration. The animal population refers to the number of animals being raised by the holding on the reference date, regardless of ownership. Animals raised include those present on the holding, as well as those being grazed on communal grazing land or in transit at the time of enumeration. Bees are counted on the basis of number of hives.

A.152. A holding is raising an animal if it has primary responsibility for looking after the animal on a long-term basis and making day-to-day decisions about its use. Most holders own and raise their own animals, but sometimes they raise animals belonging to someone else under some form of lease agreement. This may involve payment in cash or in other forms such as a share of the livestock produce. A distinction must be made between raising an animal and being employed by an animal owner to look after the animals, where the animal owner is the decision-maker. Often, such arrangements are complex; for example, a person may work as an employee under the condition that any offspring of the livestock being cared for belong to him/her. Here, he/she may be an agricultural holder in respect of some livestock, but working as an employee for other livestock.

3.4.2 Supplementary Items

0401 Type of Livestock Production System (for the holding)

- Nomadic or totally pastoral
- Semi-nomadic or semi-pastoral
- Sedentary pastoral
- Ranching

A.153. The livestock production system refers to the general characteristics and practices of raising livestock on the holding. Four systems are identified:

- Nomadic or totally pastoral refers to livestock raised in a situation where the agricultural holder has no permanent place of residence and does not practice regular cultivation. Livestock move from place to place with the agricultural holder and his/her household, depending on the season and availability of feed or water.
- Semi-nomadic or semi-pastoral refers to livestock raised by holders who live a semi-nomadic life. Typically, the holder has a permanent residence to which he/she returns for several months of the year according to seasonal factors. Alternatively, the holder establishes a semi-permanent home for several months or years and may cultivate crops as a supplementary food source. Herds are moved with the holder and his/her household.
- Sedentary pastoral refers to livestock raised by holders who have a permanent residence. Often, livestock are raised in combination with growing crops.
- Ranching refers to large-scale livestock activities carried out on large areas of land set aside for extensive grazing.

A.154. Many economies find this topic unnecessary. Nowadays, nomadic and semi-nomadic households are not common and the majority of holdings are sedentary pastoral. Often, ranching is limited to a small number of corporations or government holdings, which may be able to be identified through the sector of the agricultural holding in Item 0002.

A.155. The reference period for the collection of data on type of livestock production system is a single point of time, usually the day of enumeration.

0402 Use of Veterinary Services (for the holding)

A.156. Veterinary services cover all professional veterinary services used to protect animal health for the livestock kept on the holding, including treatment of diseases, artificial insemination, vaccination, and surgical procedures. It includes services provided by government organizations, such as through veterinary field workers, as well as by the private sector.

A.157. Data on the use of veterinary services may be collected in two ways. Data for the holding as a whole can be useful as an indicator of whether such services are generally available to the holding. Data for each major livestock type can help in assessing the animal health situation of each livestock type. Economies collect data in the form suited to their needs.

0411 Number of Animals: Age and Sex (for each livestock type)

A.158. Age of livestock data are collected in suitable age groupings, depending on the livestock type and sometimes the breed of the animal. Typical age groupings are:

- Cattle, buffaloes: less than 1 year; 1 year or more to less than 2 years; 2 years or more.
- Sheep, goats, pigs: less than 1 year; 1 year or more.

- Horses, camels, mules/hinnies, asses: less than 1 year; 1 year or more to less than 2 years; 2 years or more to less than 4 years; more than 4 years.
- Poultry: young birds (for example, aged less than three weeks); adult birds.
- Other animals: according to circumstances.

A.159. Economies often collect age and sex data only for the major livestock types. For poultry, it is often not necessary to distinguish between male and female young birds; for example, chickens may be divided into: adult males; adult females; chicks.

A.160. The reference period for the collection of all data on animal numbers is a single point of time, usually the day of enumeration. For more information on the measurement of livestock numbers, see paragraphs A.149– A.152.

0412 Number of Animals According to Purpose (for each livestock type)

A.161. Purpose refers to the main reason for the animals being kept. This is usually clear-cut, as specific breeds of animal are used for certain purposes. The specific purposes shown will depend on the type of livestock and local conditions. Normally, the following main purposes are identified:

- Cattle, buffaloes: milk; meat; draught power; breeding.
- Sheep, goats: milk; meat; wool; breeding.
- Pigs: meat; breeding.
- Horses, camels, mules/hinnies, asses: milk; meat; draught power; breeding.
- Poultry: meat; eggs; breeding.
- Other animals: according to circumstances.

A.162. The time reference for animal numbers by purpose is the day of enumeration, consistent with Item 0411. To assess the main purpose, reference should be made to the main use of the animals during the census reference year or the intended main use in the future. Economies usually collect data on purpose for the major livestock types only.

0413 Number of Milking Animals According to Milk Status (For each livestock type raised for milking)

- In milk
- Dry

A.163. This item relates to the livestock types raised for milking, as identified in Item 0412. For the purposes of the agricultural census, a milking animal is defined as an animal present on the day of enumeration that has been milked at some time during the census reference year. Milk status refers to whether the milking animal is in milk or dry on the day of enumeration.

0414 Number of Animals Born (for each livestock type)

0415 Number of Animals Acquired (for each livestock type)

0416 Number of Animals Slaughtered (for each livestock type)

0417 Number of Animals Disposed of (for each livestock type)

- Sold or otherwise disposed of for slaughter
- Other disposals

0418 Number of Animals Died from Natural Causes (for each livestock type)

A.164. These five items provide information on the population dynamics of livestock herds, such as measures of reproductive rates and take-off rates. Economies should decide on the livestock types to be covered by these data, according to domestic conditions.

A.165. The five items refer to the number of events (such as births and deaths) during a given reference period. The reference period depends on the type of livestock and operational factors. For cattle, buffaloes and other large animals, a one-year reference period – normally, the census reference year – is usually taken. For smaller animals, such as sheep, goats and pigs, a six-month reference period is often used. For poultry, a one-month reference period is often most suitable.

A.166. Number of animals born refers to births during the reference period to animals that were part of the holding at the time of the birth. Births to animals belonging to another holding should not be included.

A.167. Number of animals acquired refers to purchases or other livestock acquisitions by the holding during the reference period. This includes animals received as gifts or as payment for work.

A.168. Number of animals slaughtered refers to the amount of slaughtering during the reference period of animals that were being raised on the holding. This includes slaughtering carried out on the holding, as well as slaughtering carried out by someone else on behalf of the holding. Sales of live animals for slaughtering – for example, to an abattoir – should be shown as disposals under Item 0417. Slaughtering of other people's animals on the holding should not be included.

A.169. Number of animals disposed of refers to sales or other disposals during the reference year of animals being raised on the holding. It includes animals sold, as well as animals given as a gift, for payment for services, or for other reasons. Two types of disposal are shown. Sold or otherwise disposed of for slaughter includes all disposals of animals for the purpose of slaughtering. This is usually in abattoirs, meat packing plants or butchers' shops, but also includes donations of animals for slaughter for festivals and other community events. Slaughtering carried out on a fee basis by, for example, a butcher on behalf of the holding should be included under slaughtering in Item 0416. Other disposals include sales and other disposals that do not involve slaughtering.

A.170. Number of animals died from natural causes refers to deaths from natural causes during the reference year of animals that were being raised on the holding at the time of their death.

0419 Types of Feed (for each livestock type)

- Primary products
  - — Produced on the holding
  - — Purchased
- Processed products

A.171. Economies should decide on the livestock types to be covered by this item, according to domestic conditions. Type of feed refers to the source of feed for the livestock type for a given reference period, usually the census reference year. More than one type of feed may be used for a specific livestock type during the reference year; for example, animals may be grazed during the summer but need to be hand-fed during the winter.

A.172. Primary products include green fodder such as pasture grasses, forage crops, other crops and tree leaves, as well as harvested by-products and hay. This is sub-divided into whether it was produced on the holding or purchased. Processed products include concentrates and compound feeds.

3.5 THEME 05: AGRICULTURAL PRACTICES

3.5.1 Core Items

0006 Main Purpose of Production of the Holding

- Producing mainly for home consumption
- Producing mainly for sale

A.173. The aim of this item is get a broad indicator of the extent to which agricultural holdings are participating in the market economy. Purpose of production data are usually collected only for agricultural holdings in sector "single-holding household" in Item 0002.

A.174. Where a holding sells some produce and uses the rest for home consumption, main purpose should be which of the two – home consumption or sale – represents the larger value of agricultural production. Sale includes selling produce for cash or in exchange for other produce (barter). Disposal of agricultural produce in other ways – for example, for payment of labor, sending to family members, gifts, or payment of taxes – should not be considered in assessing the main purpose of production.

A.175. Data on main purpose of production can be collected for any suitable reference period, such as the main harvest or the census reference year. Several questions may be needed to obtain this item.

3.5.2 Supplementary Items

0501 Use of Agricultural Pesticides (for the holding)

- Insecticides
- Herbicides
- Fungicides
- Rodenticides
- Other pesticides

A.176. Pesticides are substances intended to prevent, destroy or control in plants or animals diseases and pests, including vectors of human and animal diseases, unwanted species of plants, or to control the behavior or physiology of pests or crops during production or storage. They include insecticides, herbicides, fungicides, acaricides, termiticides and rodenticides and other substances. The time reference for pesticide data is the census reference year.

A.177. Insecticides are substances used to destroy, control or repel insects. Herbicides are substances used to destroy or inhibit the growth of plants such as weeds. Fungicides are substances that destroy or control the growth of fungi. Acaricides and termiticides are used for the control of mites, ticks and termites. Rodenticides are substances that destroy, kill, repel or control rodents. Other pesticides include substances intended for use as a plant-growth regulator, defoliant, desiccant, fruit thinning agent, or sprouting inhibitor and substances applied to crops either before or after transport.

0502 Use of Good Agricultural Practices (for the holding)

A.178. The concept of Good Agricultural Practices (GAP) refers to practices adopted by farmers to ensure that agricultural products are safe, of high quality, and produced in an environmentally and socially responsible way. GAP has many components, including practices related to soil and water management, cropping systems, crop protection, livestock rearing, animal health, on-farm processing, working conditions for farm workers, waste management, and landscape and wildlife protection. Some specific GAP related practices are: integrated pest management (IPM); integrated production systems; and conservation agriculture, such as minimum tillage cultivation. GAP related topics are important given the increasing globalization of the food economy and the problems many economies face in meeting the standards required to participate in international markets.

A.179. It is not possible to recommend specific GAP related items for the agricultural census. There is no standard concept of GAP, and practices and standards vary from economy to economy depending on domestic conditions and agricultural markets. Some practices are specific to particular crops. In some economies, particular types of GAP practices are promoted. Economies need to determine the types of practices important to their own agricultural production and marketing.

0503 Use of Organic Agricultural Practices (for the holding)

A.180. Organic agriculture is an agricultural production system that promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. Organic agriculture is based on specific standards for achieving socially, ecologically and economically sustainable agro-ecosystems. A key feature of organic agriculture is that chemical fertilizers and pesticides are not used. Other practices such as the use of genetically modified (GM) crops are also proscribed. Terms such as "biological" and "ecological" are sometimes used to describe organic agriculture. Organic agriculture may apply to crops or livestock. Requirements for organically produced foods differ from those for other agricultural products in that production procedures are an intrinsic part of the identification and labeling of, and claim for, such products.

A.181. For the purposes of the agricultural census, an agricultural production system must satisfy several conditions to be considered organic.

- It must be organic by intent and not by default. Thus, non-sustainable production systems that do not use synthetic inputs are not considered organic.
- The produce must mainly be for sale, not for self-consumption. This is because the market, through pricing mechanisms and certification requirements, provides the best way to assess whether a product is organic.
- The produce must be labeled or otherwise recognized by consumers as organic. Many economies have a domestic certification system to certify that products have been produced in accordance with organic standards. Non-certified organic food may be sold in farmers' markets or at the farm-gate, where the consumer knows where the produce comes from, and (usually) is prepared to pay a premium price for it because it is recognized as organic.

A.182. Item 0503 relates to whether organic agricultural practices were used on the holding during the census reference year.

0504 Use of Genetically Modified Crops According to Crop Type (for the holding)

A.183. Item 0504 relates to whether specific types of genetically modified crops were used on the holding during the census reference year. GM crops are living organisms that possess a novel combination of genetic material obtained through the use of modern biotechnology.

0505 Selected Machinery and Equipment Used on the Holding by Source (for the holding)

A.184. This item identifies machinery and equipment used on the holding, wholly or partly for agricultural production. The reference period is usually the census reference year. Machinery and equipment used exclusively for purposes other than agricultural production should be excluded. Machinery or equipment owned by the holder, but not used should also be excluded.

A.185. A broad concept of machinery and equipment is used for the agricultural census, covering all machinery, equipment and implements used as inputs to agricultural production. This includes everything from simple hand tools, such as a hoe, to complex machinery such as a combine harvester. However, the main interest centers on farm mechanization. Advanced economies focus on machinery such as tractors, harvesting machines and office equipment. However, less developed economies may be interested in some animal or even hand-powered items of equipment, as well as machinery. Items of machinery and equipment should be clearly described; a seeder, for example could be anything from simple manual seeding device to a complex piece of machinery. To help identify machinery and equipment items for the agricultural census, a classification of machinery/equipment is given in Appendix 6 (FAO, 2005), along with a list of some of the major items under each heading. Economies might like to further sub-divide items – for example, by capacity.

A.186. Source of the machinery/equipment refers to the means by which the holder obtained the right to use the specific item. The following response categories are recommended:

- Owned solely by the holder or members of the holder's household
- Owned by the holding jointly with other holdings
- Provided by the landlord
- Provided by other private holders (excluding cooperatives)
- Provided by a cooperative
- Provided by a private agricultural service establishment
- Provided by a government agency

0506 Non-Residential Buildings (for the holding)

A.187. This item identifies non-residential buildings on the holding, used wholly or partly for agricultural purposes. The reference period is usually the census reference year. Non-residential buildings used exclusively for purposes other than agricultural purposes should be excluded. For each type of non-residential building the number, tenure and size should be collected.

Type of non-residential building

- For keeping livestock other than poultry (area)
- For keeping poultry (area)
- For storing agricultural products (area or volume)

- For mixed or other purposes (area)

Tenure of non-residential building

- Owned
- Rented
- Other

0507 Percentage of Each Major Agricultural Product Sold (for the holding)

A.188. This item is important for economies with significant home consumption of agricultural produce. Only the most important staple food crops, such as rice, wheat, maize and cassava, should be included. Percentage should relate to the quantity of production. Usually, this item is collected in ranges such as: 0–19%; 20–49%; 50% or more. Data for this item can be collected for any suitable reference period, such as the main harvest or the census reference year.

3.6 THEME 06: AGRICULTURAL SERVICES

Supplementary Items

0601 Receipt of Credit For Agricultural Purposes (for the holding)

0602 Source of Credit (for the holding)

0603 Type of Collateral for Credit (for the holding)

- The holder's land
- Other assets
- Other type of collateral

0604 Period of Loan or Credit (for the holding)

A.189. Credit for agricultural purposes refers to any type of credit received for purposes related to the operations of the agricultural holding. This includes credit for purchasing crop and livestock inputs, constructing farm buildings, and purchasing farm machinery. Credit not related to agricultural operations, such as for construction of the holder's house, for other family businesses, or for consumption expenditure, should be excluded.

A.190. Receipt of credit refers to whether credit was made available during the reference year, not whether there was outstanding credit at the time of the census. A holder may have made use of credit on more than one occasion during the year, and therefore more than one source or type of collateral may be reported. Credit received by the holder as well as members of his/her household should be included.

A.191. The term "credit" is used widely to cover borrowing money directly, as well as buying goods and services on credit. Borrowing money may be done through a lending institution, other organizations, or persons for a specific purpose such as buying a tractor. Buying goods and services on credit refers to an arrangement for buying goods or services where payment is delayed beyond delivery, such as where fertilizer is purchased on the basis that payment will be made after the crop has been harvested.

A.192. In Item 0602, source of credit refers to who provided the credit. The specific source classes will depend on the institutional arrangements for credit in the economy. Typical groups are:

- Commercial bank
- Agricultural development bank
- Cooperative credit society
- Money lender
- Input supplier
- Self-help group
- Family or friends
- Government
- Other sources

A.193. In Item 0603, collateral is defined as assets pledged as security for a loan of money, which means that if the borrower defaults on the terms of the loan, the collateral may be sold and the proceeds used to pay off the loan. For the purpose of the agricultural census, collateral is used in a wider sense to also cover guarantee provided for the purchase of goods and services. This is usually related to the production of agricultural goods, but may also be based on assets.

A.194. The collateral for larger holdings is often the holder's land. This is prevalent where there is a well-developed land tenure system with legal ownership of land. Otherwise, other assets may be used as collateral. For a loan to buy farm machinery, for example, the purchased machinery may be used as collateral. Other type of collateral covers the purchase of goods and services on credit based on agreements to pay at a later date, or credit received without any collateral on a personal guarantee basis.

A.195. Period of loan or credit refers to the period over which the loan or credit is to be paid off, as agreed at the time the loan was received. Where credit was received more than once during the reference year, the period should be reported for the loan or credit of highest value. Normally, the period of loan or credit is reported in ranges to reflect the likely reasons for using credit, such as for short-term (for the current crop) or long-term (for major capital outlays). Typical groupings are:

- Less than 12 months
- 12–35 months
- 36 months or more

0605 Sources of Agricultural Information (for the holding)

- Extension services
- Radio
- Television
- Newspapers
- Agricultural newspapers
- Input agencies
- Internet
- Other farmers
- Other

A.196. Sources of agricultural information refer to where the holder received information to help manage the agricultural holding. This includes information on weather, selection of crop varieties, new agricultural practices, farm machinery, credit facilities, plant diseases and pests, marketing, and commodities or crop varieties being promoted by the Government. The reference period is the census reference year.

A.197. Most farmers use various sources of information. Usually, economies prefer to collect data on all the sources. Extension services refer to advice received through government or non-government extension services, and is covered in more detail in Item 0606.

0606 Sources of Agricultural Extension Services (for the holding)

A.198. Agricultural extension refers to the provision of agricultural advice and information to crop and livestock producers. Extension services may be provided by government institutions,

non-government organizations, farmer organizations, educational institutions, informal grass-roots organizations, and others. Extension services may cover advice to farmers in areas such as farm management, selection of crop varieties, use of inputs such as fertilizers, credit, farm mechanization, animal health, plant protection, sustainable development, and marketing. Extension services may also be used by Governments to distribute inputs, disseminate market information, and promote the production of particular commodities or crop varieties.

A.199. In most economies, government is the principal provider of extension services through its network of agricultural field staff. The organization of government extension services varies from economy to economy. Sometimes, extension services are centralized in a single ministry with all-round extension officers providing advice in all disciplines. In other economies, there are specialized extension services in crops, livestock and perhaps other fields.

A.200. There are many different methods of implementing extension services. Often, extension workers visit farmers to provide on-the-spot advice. Demonstrations of new farming practices or technologies are sometimes arranged for small groups of farmers, or more formal training programs organized for larger groups of farmers. Sometimes, study tours are arranged for farmers to observe agricultural practices in other places. Usually, agricultural extension is free of cost to the farmer; sometimes, it is not.

A.201. Item 0606 refers to the use of agricultural extension services by the holding during the census reference year. It refers to personal contact with extension personnel or direct participation in extension activities such as a farm demonstration. It does not include accessing extension material though printed brochures, radio, television or the Internet. Also, extension services should be limited to formal contacts with extension workers specifically employed for that task; advice received from other informal sources should not be included. A farmer may have received extension services from more than one source.

A.202. The categories for sources of agricultural extension will depend on the way extension services are organized in the economy. Economies may want to identify the discipline (such as crops or livestock) and the type of organization providing the service (such as government institution or farmer organization). Typical source categories are:

- Government organization
  - — Crops
  - — Livestock
- Farmer association
- Other

0607 Travelling Time to Nearest Periodic or Permanent Agricultural Produce Market (for the holding)

A.203. This item is included to help assess how easy it is for farmers to access markets. Travelling time is usually expressed in ranges, such as:

- Less than 30 minutes
- 30–60 minutes
- 60–120 minutes
- More than 2 hours

A.204. Sometimes, travelling times vary according to, for example, the wet and dry seasons. Some economies may wish to collect these data for different seasons.

A.205. Periodic or permanent agricultural produce market refers to a market where farmers can bring their produce for sale. The markets operated every day or on certain days of the week.

3.7 THEME 07: DEMOGRAPHIC AND SOCIAL CHARACTERISTICS

3.7.1 Core Items

0005 Household Size

A.206. Household size is the number of members of the holder's household. This can be obtained either by listing all household members or asking a direct question on the number of household members. A household is one or more persons living together who make common provision for food or other essentials for living (see paragraph 3.26. FAO. 2005).

A.207. It is recommended that household data only be collected for agricultural holdings in sector "single-holding household" in Item 0002. It would be difficult to interpret household data for other types of holdings and could lead to double counting of household members. Household data are not normally provided for other types of holdings in the household sector in Item 0002, Some economies collect household data for "multiple-holding households" in Item 0002 by referring to the group of persons within the household operating the holding.

A.208. Household size can be measured in two ways: (i) persons present on the day of enumeration; or (ii) persons who are usually resident in the household. The usual residence approach – called the de jure concept – is recommended for the agricultural census, and is the way official population estimates are normally made. Usually, it is not difficult to identify a person's place of usual residence. However, sometimes members of a family are studying or working away from the family home and return home regularly. The treatment of such cases should be clearly stipulated.

A.209. With a de jure concept, the data on household size relates to persons who, at the time of the census, are usually resident in the household.

3.7.2 Supplementary Items

0701 Whether Holding Is Part of an Agricultural Household (for the holding)

A.210. An agricultural census covers all units engaged in agricultural production activities, regardless of size or importance. For some households, agricultural production on the holding is the household's only or predominant activity, but for other households, it may only provide a secondary source of income. A household may be engaged in other economic production activities (see Item 0016) or its members may work in paid jobs. A household with a small holding of, for example, only 0.4 ha of land may or may not be food secure, depending on the extent to which it relies on the agricultural holding for its livelihood.

A.211. Item 0701 is recommended for inclusion as a supplementary item to identify what might be termed "genuine farmers". This can provide an important classification item for the census tabulation. It can also be useful for sampling frame purposes. Item 0701 relates only to holdings in sector "single-holding household" in Item 0002.

A.212. A household containing an agricultural holding may have four sources of income: (i) agricultural production income; (ii) income derived from economic production activities other

than agricultural production; (iii) income from paid employment; and (iv) pensions, investment income and remittances. An agricultural household is a household for which agricultural production income is the largest of these four income sources. Agricultural production income includes income from growing crops and raising livestock; it excludes income from a paid agricultural job. Income includes income in cash and in kind. For more information on the concept of agricultural household, see *Handbook on Statistics on Rural Development and Agricultural Household Income* (UN et al, 2005, Chapter IX).

A.213. Note that there are various types of non-agricultural households. For some, agricultural production is a sideline activity to the household's main economic production activity or employment. For others, the household is forced to rely on other sources of income because income from agricultural production is low. The latter may be of particular concern to agricultural policy-makers, and economies may wish to draw out this distinction in the analysis.

A.214. It is not necessary to collect detailed income data to determine whether the holding is part of an agricultural household. Income data are difficult to collect, even in an in-depth sample survey, and is not normally feasible in an agricultural census. Instead, respondents should be asked to provide an overall assessment of their agricultural production activities in relation to the three other sources of income. The important thing is not to get quantitative measures of income from the different sources, but to distinguish between agricultural and non-agricultural households. Normally, the reference period for the collection of agricultural household data is the census reference year.

0702 Ethnic Group of Household Head or Agricultural Holder (for the holding)

A.215. In many economies, there are major differences in agricultural practices between different ethnic groups, which are important to measure in an agricultural census. For the agricultural census analysis, a single ethnic group indicator for the holding is needed, and this is usually done by referring to the household head or the agricultural holder. This may not always be appropriate.

A.216. The ethnic groups used by an economy could be based on nationality, religion, language or customs, depending on their importance in the community and their dissimilar agricultural characteristics. There should also be consistency with the population census and other statistics.

0711 Sex (for each household member)

- Male
- Female

0712 Age (for each household member)

A.217. Age refers to the age in completed years at the time of the census. Data on age may be collected by asking directly for the age or by obtaining the person's date of birth. Age is sometimes difficult to collect. In some economies, people have different ways of calculating age, such as age next birthday. There is also a tendency for people to round ages to the nearest five or ten years. Date of birth can also be difficult to collect. Often, it is known only according to an alternative calendar such as a lunar calendar. Sometimes, people can only

identify their date of birth in relation to major events, or may only know the season not the date. There are various data collection tools available to help overcome these problems.

0713 Relationship to Household Head or Other Reference Person (for each household member)

A.218. Relationship data are collected by first identifying the household head (or any other reference person) and then recording the relationship of each other household member to that person. In the agricultural census, relationship data are only collected to determine household and family composition. Therefore, it doesn't matter who the reference person is or, if it is the household head, whether that title reflects the person's role. Economies may use any reference person considered most appropriate to domestic circumstances. It is not intended that household head data – for example, by gender – will be analyzed in the agricultural census. Instead, census data will be analyzed in relation to different household composition types, such as a married couple with children or an extended household.

A.219. The relationship categories should be based on international standards used in the population census program (UN, 1998, paragraph 2.73), ensuring consistency with other economy-wide statistics. The recommended categories are given below. Some economies may wish to identify more complex relationship structures, such as child/parent relationships for different family units within a household.

- Head
- Spouse
- Child
- Spouse of child
- Grandchild or great grandchild
- Parent or parent of spouse
- Other relative
- Other unrelated person

A.220. Households should be divided into household composition types based on the family nucleus. The following groupings used in the population census (UN, 1998, paragraph 2.82) are usually suitable:

- One-person household
- Nuclear household
  - — Married couple family with children
  - — Married couple family without children
  - — Father with children
  - — Mother with children
- Extended household
- Composite household

0714 Marital Status (for each household member)

A.221. Marital status is the status of the household member in relation to the marriage laws or customs of the economy. The marital status categories should be based on international standards used in the population census program (UN, 1998, paragraph 2.96), ensuring consistency with other economy-wide statistics. The following groupings are recommended:

- Never married

- Married
- Widowed and not remarried
- Divorced and not remarried
- Married but separated

A.222. Economies may wish to take local conditions into account in determining the marital status categories. In some economies, the category “consensual union” may be needed to reflect unions outside marriage laws or customs. Other economies may need to take into account concubinage, polygamous or polyandrous practices.

A.223. Marital status is sometimes collected for all persons, regardless of age, but often it is restricted to those above the minimum legal marriage age. Whichever approach is taken, economies should show marital status data in the census tables for persons aged 15 years and over, to provide international comparisons.

0715 Educational Attainment (for each household member)

A.224. Educational attainment data are useful in an agricultural census to examine the effects of education on characteristics such as cropping systems, agricultural practices and household food security. Educational attainment refers to the highest grade of formal education completed or attended by a person. In the agricultural census, educational attainment data should be collected for both the agricultural holder and the agricultural holder’s spouse, if present, as the educational levels of both can be important factors in agricultural and household activities.

A.225. Data on educational attainment needs to be recorded in suitable categories. Attention should be paid to consistency with other statistical collections, especially the population census, and to the International Standard Classification of Education (ISCED) (UNESCO, 1997). For international comparison purposes, educational attainment should be classified into at least three levels of education: primary, secondary, and post-secondary. Each level may be further sub-divided to meet domestic needs.

3.8 THEME 08: FARM LABOR

3.8.1 Basic Concepts in Labor Statistics

A.226. Theme 08 covers items related to the two types of labor inputs on agricultural holdings: (i) labor provided by household or family members, and (ii) paid outside workers.

A.227. Data on farm labor in the agricultural census should be based on the recommendations on labor statistics provided by the International Labour Organization (ILO, 2000). Under ILO guidelines, the concept of activity status, broadly speaking, is used to measure whether a person of working age is part of the supply of labor for the production of economic goods and services. A person who is part of the supply of labor is said to be economically active, whereas a person who is not part of the supply of labor is said to be not economically active.

A.228. For the purposes of defining activity status, economic goods and services are defined according to SNA principles and covers the production of goods and services for sale or for home consumption (UN et al, 1993). For agricultural work, it covers all crop and livestock production and related activities, including supplying water, post-harvest activities, and preparation of food for employees on the holding. It does not include domestic and personal services provided for the household's own consumption.

A.229. There are two main ways to measure a person's activity status. One is the concept of "currently active", which measures activity status in relation to a short reference period such as a week. The other is the concept of "usually active", which measures a person's main activity status over a long reference period such as a year. One of the advantages of the "currently active" concept is that data collection is easier because it only requires activity information for a short reference period. "Current activity" is usually preferred for making international comparisons. However, "usual activity" is generally used in the agricultural census because it is more suited to measuring the seasonal aspects of agricultural work and because the emphasis in the census is on the source of labor inputs rather than measuring employment as such. The "usually active" concept is recommended for use in the agricultural census.

A.230. A person is determined to be usually economically active or not usually economically active according to the person's main or usual activity during a long specified period such as a year. Criteria need to be set for this purpose, based on the number of months, weeks or days of activity during the long reference period. For example, a person would be classified as usually economically active if their total period of employment and unemployment was 50 percent or more of the length of the long reference period (that is 26 weeks or more for a reference year). A person would be classified as not usually economically active if their total period of employment and unemployment was less than half the reference period. In order to capture agricultural labor input completely, the agricultural season could be used for the long reference period, instead of the reference year. However for assessing employment statistics in general, it is the reference year that is mostly used. Within the category usually economically active, persons may be usually employed if the period of employment during the reference period exceeded that of unemployment, otherwise they would be usually unemployed. Employed persons work in one or more jobs, and employment data – such as status in employment, occupation, and time worked – are obtained about each job. For the

census of agriculture, employment data should focus on those jobs that are related to agriculture, separately identifying main jobs and secondary jobs.

A.231. The minimum age limit for economically active persons should be set in accordance with domestic conditions, but should not be higher than 15 years. A lower minimum age limit may be appropriate in developing economies where children often participate in agricultural work. To facilitate international comparisons, tabulations should distinguish between persons aged under 15 years and those aged 15 years and above. Where economies set the minimum age limit below ten years, tabulations should also distinguish children aged under ten years. It is not normal to apply a maximum age limit as elderly persons can still make a contribution to agricultural work.

A.232. As for all items in the agricultural census, economies need to carefully design questionnaires for the collection of farm labor data, suitable to domestic circumstances. Activity status data can only be collected by asking each person a series of specific questions about his/her work activities or, if he/she is not working, about his/her availability for, and steps taken to find, work. Accurately measuring usual activities over a twelve-month reference period is difficult and special data collection measures are needed to ensure that reporting is complete and accurate. Efforts must also go into ensuring that data are not biased as a result of enumerators misunderstanding the concept of activity status, especially for women and other family members contributing labor to work on the holding.

A.233. An additional point to bear in mind is that a person who is usually employed over the reference period (year) may not necessarily be always employed in agricultural work. It may be useful, therefore, to identify agricultural labor separately from non-agricultural labor and/or to ask specific questions about any job during the agricultural season that is related to agriculture (including jobs that are not the main job). More detail on international standards for labor statistics is contained in various ILO publications (ILO, 1990; ILO, 2000). Economies should refer to this material to clarify the treatment of special cases.

3.8.2 Supplementary Items

0801 Activity Status (for each household member of working age)

- Economically active
  - — Employed
  - — Unemployed
- Not economically active

A.234. Activity status refers to whether a person is usually economically active or usually not economically active (see paragraph 11.230; ILO, 2000, pp. 24–28).

A.235. An employed person is one whose main activity during the reference year was to be in paid employment or self-employment. Paid employment includes those at work, as well as those with a job but temporarily not at work because of illness or holiday, but retaining a formal attachment to that job. Formal job attachment needs to be determined according to domestic circumstances, taking into account the continued receipt of wages and the guarantee of a return to the job. Self-employment includes those operating a business or otherwise working for profit or family gain, including contributing family workers (see paragraph A.244).

A.236. The family is often an important source of labor on agricultural holdings and should be given special attention in measuring the activity status of household members. Special care is needed with homemakers. Activities related to care of the home or children do not constitute employment in a statistical sense, but many homemakers also do some work on the holding, especially in peak periods such as during crop planting or harvesting. Many homemakers also have other specific tasks on the holding, such as looking after the kitchen garden or caring for livestock. In measuring activity status, some economies set a minimum requirement for the amount of time worked; in doing this, economies should ensure that the contribution of unpaid family workers, especially women, are fully reflected.

A.237. An unemployed person is one whose main activity during the reference year satisfies the following three criteria:

- without work, that is he/she is not employed;
- currently available for work, that is he/she would be willing to do work if work was available; and
- seeking work that is he/she is taking specific steps to find work.

A.238. Criteria for determining "available for work" and "seeking work" must be established based on domestic circumstances, taking into consideration how the labor market is organized and how people find jobs. Persons not seeking work because of temporary illness, previous arrangements to start a new job in the future, or on temporary or indefinite lay-off without pay, are included as unemployed.

A.239. The unemployment concept is difficult to apply in economies where the labor market is not well organized or where self-employment or informal labor arrangements are predominant. This commonly applies in rural areas of developing economies. Often, the "seeking work" criterion is relaxed because many people do not seek work because they believe that no jobs are available.

A.240. A person is not economically active if his/her main activity status during the reference year was neither employed nor unemployed. Typical examples are: persons below the minimum age for measuring economic activity; homemakers; students; persons too old or too sick to work; and persons living from the proceeds of property, investments, interest, rent, royalties or pensions.

0811 Status In Employment of Main Job (for each economically active household member)

- Employee
- Own-account worker
- Contributing family worker
- Member of producers' cooperative
- Not classifiable

A.241. Status in employment refers to status of an economically active person with respect to the type of employment contract the person has with his/her job (ILO, 2000, pp. 20–23). Note that activity status relates to whether the person was mainly employed, unemployed or not economically active during the reference year, while status in employment refers to the characteristics of a particular job – in this case the person's the main job – or (for the unemployed) the status in work of the person's last job.

A.242. An employee is a person in a paid employment job (see paragraph 11.235). Paid employment jobs are those which provide remuneration not directly dependent on the revenue of the unit for which the person works. Typically, an employee receives wages and salaries for the time worked. However, remuneration may also be in the form of in-kind payments such as food, or on a commission or piece-rate basis.

A.243. An own-account worker is one who is working on his/her own account, or with one or more partners, in a self-employment job (see paragraph A.235), where that person has overall responsibility for the management of the producing unit. In a self-employment job, the remuneration is directly dependent on the profits derived from the goods and services produced. Agricultural holders are own-account workers if their main job is work on the holding.

A.244. Contributing family workers are those who are working in a self-employment job in an establishment operated by a person living in the same household, and whose level of responsibility or commitment in terms of working time or other factors is not sufficient to be considered an own-account worker. Thus, the agricultural holder is the own-account worker and any other household member whose main job is working on the holding is a contributing family worker. Where it is customary for people to work without pay in a business operated by a related person not living in the same household, the requirement of living in the same household is often relaxed.

A.245. A member of a producers' cooperative is one working in a self-employment job as a member of a cooperative, where each member takes part in managing the cooperative on an equal footing with other members.

A.246. Not classifiable covers those such as the unemployed who cannot be classified to any of the previous categories.

0812 Occupation of Main Job (for each economically active household member)

A.247. Occupation is defined as the main tasks and duties carried out by an employed person in a particular job (ILO, 1990, pp. 2–5). Occupation relates to a particular job; a person may have more than one job, each with its own occupation. For the agricultural census, occupation data are usually collected in respect of the main job. The occupation of an unemployed person relates to the work done in a previous job. Occupation is not relevant if the person is not economically active.

A.248. Occupation should not be confused with industry: occupation is the type of work done by the person, while industry is the activity of the establishment in which the person works. Thus, a person working as a machine operator for a logging firm would have occupation "machine operator" and industry "forestry". Also, occupation should not be confused with status in employment, which describes whether a person is an employee, own-account worker, etc. (see paragraphs A.241– A.246).

A.249. Occupation should be coded according to a standard domestic occupation classification, which should be compatible with the International Standard Classification of Occupations (ISCO) (ILO, 1990). Most occupation classifications provide different levels of coding and the agricultural census should be coded at the lowest possible level consistent with

the information provided in the questionnaire and the level at which data are to be presented in the census tabulations. Usually, occupation is coded to at least the second or third levels, corresponding to the ISCO sub-major or minor groups.

A.250. ISCO provides the following ten major groups:

1. Legislators, senior officials and managers
2. Professionals
3. Technicians and associate professionals
4. Clerks
5. Service workers and shop and market sales workers
6. Skilled agricultural and fishery workers
7. Craft and related trade workers
8. Plant and machinery operators and assemblers
9. Elementary occupations
10. Armed forces

A.251. Agriculture related occupations are mainly in major groups 1, 2, 3, 6, 8 and 9, but most persons in rural areas report occupations belonging to groups 6 and 9. ISCO emphasizes the skill level required to do a particular task and a distinction is made between skilled agricultural workers (Group 6) and farm-hands/laborers, which are classified under elementary occupations (Group 9).

- Skilled agricultural workers are those whose "tasks require the knowledge and experience necessary to produce farm products" (ILO 1990, p. 6 and pp. 157–171).
- Persons with elementary occupations are those whose "occupations require the limited knowledge and experience necessary to perform mostly simple and routine tasks, involving the use of hand-held tools and in some cases considerable physical effort and with few exceptions only limited personal initiative or judgment. Tasks include: digging and shoveling; loading and unloading; raking, pitching and stocking hay; watering and weeding; picking fruit and other crops; feeding, watering and cleaning animals; etc." (ILO 1990, p. 7 and p. 258).

A.252. It can be difficult to distinguish these two occupation groups. Economies need to develop criteria suited to domestic conditions to determine what types of agricultural workers are deemed to have the skills necessary to be classified in Group 6. Also to be considered are the questions needed to provide the information necessary to code on the required basis. Just asking a single question about occupation is often not satisfactory because of confusion between occupation and industry or status in employment and it usually does not give the information needed to make a clear distinction between skilled and unskilled workers. Some economies ask two occupation related questions – the first about the kind of work done, and the second about the main tasks and duties – which provides a better basis for coding a person’s occupation. Some economies define the holder as a skilled worker and all other persons working on the holding as unskilled; this is not completely satisfactory.

0813 Time Worked in Main Job (for each economically active household member)

0814 Time Worked on the Holding (for each economically active household member)

A.253. Past agricultural census programs have used the concept of permanent/occasional worker to measure the volume of labor inputs to the holding. A permanent worker was someone whose services are used regularly and continuously during the reference year. Often, this was interpreted as working six months or more during the year. This was difficult to apply, given the seasonality of agricultural work. A person may work regularly and continuously on a holding when work is available, but that may only be for a few months of the year. Alternatively, a person may work continuously but only for a few hours a week.

A.254. It is recommended that a different approach be used for the 2010 round of agricultural censuses, based on the concept of time worked (ILO, 2000, pp. 39–40). Time worked is the time spent working in a particular job during the twelve-month reference period. Time worked includes regular working hours as well as overtime, time spent waiting or standing by, and other short breaks. It excludes meal breaks and absences because of holidays or sickness. Two time worked items are recommended: time worked in main job, and time worked on the holding.

11.255. Time worked has two elements. Full-year/part-year work measures the number of months or weeks of work carried out during the year. Full-time/part-time work measures the number of hours worked per day or week, as assessed against some sort of norm such as a 40-hour week.

A.256. Economies should give careful consideration to the application of the time worked concept, taking into account domestic circumstances and the way in which the time worked data are to be presented in the census tabulations. One option is to present data according to specified weeks per year and hours per day groupings. Another option is to summarize time worked according to the following categories:

- Full-time job
  - — Worked 1–3 months in the year
  - — Worked 4–6 months in the year
  - — Worked 7 or more months in the year
- Part–time job
  - — Worked 1–3 months in the year
  - — Worked 4–6 months in the year
  - — Worked 7 or more months in the year

A.257. Comparability with previous agricultural censuses could be achieved by defining permanent/occasional workers in terms of the above classes; for example, a permanent worker could be one working for seven or more months of the year in a full– or part-time job.

A.258. Much effort needs to go into designing suitable questionnaires and data collection procedures for time worked data. At a minimum, it will be necessary to ask each person about the months per year and hours per week worked for each job. However, these questions alone will not usually be sufficient to get reliable data, especially given the complex organization of

farm labor in many economies. One option is to ask detailed questions about the nature and duration of all activities carried out by each person during the year. Diaries could be used for this purpose. Such in-depth questions would improve data quality but would add to the length of the questionnaire. However, this is the rationale for the current modular approach, with in-depth data such as this being collected in a sample-based supplementary module rather than by complete enumeration in the core module.

0821 Number of Employees on the Holding: Time Worked and Sex (for the holding)

- Male employee
- Female employees

A.259. Items 0801–0814 are about the economic activity of the holding's household members and the labor they supply to the holding. The current item, Item 0821, is about the use of paid workers on the holding. The underlying concepts for these data are based on the ILO recommendations on labor statistics (see paragraphs A.226– A.232).

A.260. An employee on the holding is a person who had a job on the holding at some time during the reference year, whose status in employment for that job was "employee" (see paragraph A.242); that is, he/she worked on the holding at some time during the year in a paid employment job. This includes permanent employees, as well as seasonal, part-time and casual workers. Employees are usually paid in cash, or in the form of food or other farm produce, but there may be other remuneration arrangements. Exchange of labor should be treated as a form of paid employment. Persons employed by the household but not working on the holding are excluded. Family members are excluded from Item 0821 because their labor inputs are covered under Items 0801–0814. The term "employee on the holding" is equivalent to the term "agricultural worker other than members of the holder's household" used in previous agricultural census programs.

A.261. A distinction is made between hiring an employee to work on the holding for a defined remuneration, and engaging a contractor to provide certain agricultural services for an agreed fee. Item 0821 covers only employees. Contract work is covered in Item 0823. For more information on the difference between employees and contractors, see paragraph A.267.

A.262. The number of employees on the holding is a count of the number of persons who were an employee on the holding at some time during the reference year. Thus, a person who worked on the holding several times during the reference year is counted only once.

A.263. For the 2010 round of agricultural censuses, the concept of time worked is used to replace the permanent/occasional concept used in previous agricultural census programs. See paragraphs A.253– A.258 for more information. Time worked data for employees should be consistent with the same data for household members. In this regard, the time worked classification in paragraph A.256 should be suitable. Comparability with previous agricultural censuses can be achieved by defining permanent/occasional workers in terms of the given time worked classes.

A.264. As for all time worked data, care is needed in designing suitable questionnaires and data collection procedures (see paragraph A.258).

0822 Form of Payment For Employees (for the holding)

A.265. Item 0822 is important in economies where there are various forms of remuneration for employment of labor. It refers to the form or forms of payment used on the holding during the reference year. The form of payment for each employee is usually not reported. The payment methods can vary from economy to economy and each economy needs to determine categories suitable to domestic conditions. Typical form of payment groups are:

- With money
- With farm produce
- Exchange of labor
- Other forms of in-kind payment

0823 Use of Contractors for Work on the Holding According to Type (for the holding)

A.266. This item is about whether agricultural service contractors were used for work on the holding during the census reference year.

A.267. Using an agricultural service contractor must be distinguished from hiring an employee to work on the holding, which is covered in Item 0821. An employee is a person employed under an explicit or implicit agreement that provides the person with a certain agreed remuneration. Often, there are legal requirements attached to hiring an employee such as the provision of social benefits to the employee (such as sick leave), payment of taxes (such as payroll tax), and responsibility for work safety (such as insurance for workplace accidents). A contractor, on the other hand, is an own-account worker (see paragraph A.243), who normally receives no social benefits as part of the work carried out. Often, there are legal requirements for a contractor, such as having the required business license or payment of value added taxes. Sometimes, it can be difficult to differentiate between an employee and a contractor.

A.268. The type of contractor groupings used depends on domestic conditions. Typically, specialized work on the holding is contracted out, such as crop protection, tree pruning, crop harvesting, sheep shearing, or farm administration.

3.9 THEME 09: HOUSEHOLD FOOD SECURITY

3.9.1 Basic Household Food Security Concepts

A.269. Household food security refers to the situation where all members of a household at all times are consuming enough safe and nutritious food for normal growth and development, and for an active and healthy life. A household is food insecure if it is not able to afford to buy enough food or is limited in food supply and therefore may not be able to eat safe or nutritionally adequate food. Food security refers to conditions related to a household not producing enough food and not having enough resources to buy food; it does not refer to other causes of hunger such as dieting or physical inability to cook/buy food.

A.270. Household food security is a complex, multi-dimensional problem. Concepts such as food security, food insecurity, hunger and vulnerability are difficult to measure. Household food security may incorporate elements such as food shortages, fear of food shortages, perceptions about the quality or quantity of food eaten, and how people deal with food shortages. The nutritional quality of diets and safety of food are other elements. Access to health, sanitation, and other services also affect a household's food security situation (FAO, 2000).

A.271. Various approaches have been used to measure household food security. Some economies have developed a household food security scale, which provides an overall assessment of where each household is on the spectrum between being food insecure and food secure, based on a series of food security related questions. Other economies undertake in-depth surveys exploring all the different elements of household food security.

A.272. It is not possible to fully cover household food security in an agricultural census, and it is difficult to make specific recommendations on which household food security items each economy should include in its agricultural census. Some guidelines are provided in the paragraphs below.

A.273. Any survey involving a complex topic such as this will need extensive questionnaire development and testing. The concept of "food shortage" could be approached in different ways, such as asking about "getting enough food every day", "facing food shortages", or "not having enough money to buy food". Food shortages may be reflected in various ways such as skipping meals, eating less expensive food, or cutting the size of meals.

A.274. It is recommended that food security not be included in the core agricultural census module. For the household food security supplementary module, two broad food security indicators are proposed: (i) food shortages faced in a twelve month reference period; and (ii) fear of a food shortage in the coming twelve months. Additional items on the types of food normally eaten, anthropometric data, and the effects of natural disasters are also proposed.

3.9.2 Supplementary Items

0901(A) Whether Household Members Could Not Afford to Eat What They Normally Eat at Any Time During A Twelve-month Reference Period (for the household)

0901(B) Months in Which Food Shortage Occurred (for the household)

0901(C) Reasons For Food Shortage (for the household)

0901(D) How the Household's Eating Patterns were Affected by Food Shortage (for the household)

0901(E) Steps Taken to Alleviate Food Shortage (for the household)

A.275. Item 0901 relates to food shortages faced by the household during a previous twelve-month reference period. This takes account of seasonality in food supplies. The census reference year is usually suitable. If seasonality is not important, a shorter reference period, such as one month, may be used.

A.276. Could not afford to eat what they normally eat refers to the situation where the household finds that it is unable to maintain its normal eating patterns at any time during the reference period and is forced to make changes such as skipping meals, eating less for each meal, or eating cheaper and perhaps less nutritious food. This item relates to what the household normally eats, even if the household's normal diet is inadequate in terms of the amount of food eaten or how balanced the diet is.

A.277. Data on months in which food shortage occurred are useful to assess the seasonality of food shortages, such as before the main harvest or where natural calamities are common. A household may experience a food shortage in one or more months of the year and respondents should show each month in which the shortage occurred. For some economies, this information could be collected in terms of the frequency of food shortages, rather than months in which food was short. Here, terminology such as: "1 or 2 months of the year" and "some months of the year", or "sometimes" and "often" may be used.

A.278. Reasons for food shortage will depend on local conditions. Food shortages may be caused by exceptional events such as loss of crops, or they may be attributed to more long-term factors such as lack of land. Respondents may have more than one reason for a food shortage. Economies should develop suitable response categories for reporting these data. Some typical response categories are:

- Loss of crops
- Lack of jobs
- Inability to work because of illness or injury
- Disabled, old age
- Lack of land
- Lack of capital
- Family too big

A.279. Eating patterns affected by food shortage refer to the household's immediate response to the food shortage. Typical response categories are:

- Skipping meals
- Eating less expensive food
- Cutting the size of meals

A.280. Steps taken to alleviate food shortage refers to what the household did to try and overcome the food shortage. This will depend on domestic conditions but could include the following response categories:

- Use savings to buy food
- Take out a loan
- Sell land or livestock
- Get another job
- Start or expand a family business
- Get help from relatives or other people
- Get help from the Government
- Get help from charities

0902 Whether the Household Fears A Food Shortage During A Future Twelve-month Reference Period (for the household)

A.281. Item 0902 relates to fears of a food shortage during a coming twelve-month reference period, such as the next agricultural year.

A.282. Fears a food shortage refers to the household's fear of getting into a food shortage situation at any time during the reference period because of the threat of natural disaster, loss of crops, loss of a job, or other factors. The fear of food shortage relates to the household's own assessment of their food security situation for the coming year.

0903 Frequency of Normally Eating Selected Food Products (for the household)

A.283. This item provides information on the frequency of eating key food products. It can help to understand how diets change in the face of a food shortage or vulnerability to food shortage. The food products specified will vary from economy to economy and should focus on the food groups that best discriminate food insecurity. Thus, if households tend to respond to a food shortage by eating more maize and vegetables and less rice and meat, these food groups should be emphasized in Item 0903. It is not necessary to cover all food groups.

A.284. Data on food frequency should be collected for a relatively short reference period, such as a week or a month. The frequency can be reported in terms of categories such as: every day; often; sometimes; not at all.

0904 Effects of Natural Disasters (for the household)

0905 Extent of Loss Of Agricultural Output Due to Natural Disasters (for the household)

A.285. Items 0904 and 0905 are suitable for economies where natural disasters are prevalent and, when they occur, can have a major impact on the food security situation of the people affected. Normally, the census reference year is taken as the time reference.

A.286. Item 0904 refers to whether the household's food security situation was affected by specified natural disasters. For the purposes of the agricultural census, natural disasters include the major climatic and physical events, as well as major pest attacks. The types of natural disasters identified will depend on domestic circumstances. The following response categories may be suitable:

- Floods or tidal waves
- Drought
- Typhoons or hurricanes
- Pests
- Other

A.287. A household may have suffered because of more than one disaster and should be reported accordingly.

A.288. Item 0905 covers the extent of the loss as a result of the disasters reported in Item 0904. The extent of the loss of agricultural output should be measured according to suitable criteria, such as:

- None
- Slight
- Moderate
- Severe

A.289. Normally, Item 0905 relates to the overall effect of the natural disasters, not the effects of specific disasters or the effects on specific crops or livestock. For crops, loss is usually assessed in terms of the effect on crop production in comparison with a normal year, such as: slight – less than 20 percent lower; moderate – 20–40% lower; severe – more than 40% lower. Similar criteria can be used for livestock.

0911 Height and Weight (for children aged under 5 years)

A.290. The outcome of food insecurity is that people do not eat enough food and, for children, this is reflected in their growth. Data on the heights and weights of children aged under five years can be valuable in assessing the effect of household food security problems. By relating the height and weight of a child to his/her age, one can measure the following indicators:

- Underweight; that is, the child's weight is too low for his/her age. Children may also be classified as moderately or severely underweight.
- Stunting; that is, the child's height is too low for his/her age. Children may also be classified as moderately or severely stunted.
- Wasting; that is, the child's weight is too low for his/her height.

A.291. To collect these data, enumerators need to be provided with measuring instruments; namely, a measuring tape to record heights and scales to record weights.

3.10 THEME 10: AQUACULTURE

3.10.1 Core Items

0014 Presence of Aquaculture on the Holding

A.292. For the purpose of the agricultural census, presence of aquaculture refers to aquacultural production activities carried out in association with agricultural production. This means that the aquacultural activities are integrated with agricultural production, such as in rice-cum-fish culture, or that aquaculture and agriculture share the same inputs, such as machinery and labor. For more information on the treatment of aquaculture in the context of the domestic accounting framework, see Appendix 1 (FAO, 2005). Aquaculture carried out independently of agricultural production is not included; for example, a household may have independently managed and operated agricultural and aquacultural activities.

A.293. Aquaculture is the farming of aquatic organisms such as fish, crustaceans, mollusks and plants. In this context, farming refers to some intervention in the rearing process to enhance production, such as regular stocking, feeding and protection from predators. Aquaculture normally involves rearing of organisms from fry, spat or juveniles. Aquaculture may be carried out in ponds, paddy fields, lagoons, estuaries, irrigation canals or the sea, using structures such as cages and tanks. It may be in freshwater or saltwater.

A.294. A distinction must be made between aquaculture and other forms of aquatic exploitation such as capture fisheries. Capture fisheries involve catching aquatic animals or gathering aquatic plants “in the wild”. An important characteristic of capture fisheries is that the aquatic organisms being exploited are common property, as opposed to being owned by the holding as is the case for aquaculture.

A.295. The boundary between aquaculture and capture fisheries may be blurred. Where fish are caught in the wild and fattened up for sale, the fattening process should be considered as aquaculture. Limited enhancement actions taken to increase fish production, such as modifications to the aquatic habitat, should not be considered as aquaculture.

A.296. Data on aquaculture usually relate to activities carried out over a twelve-month period, usually the census reference year.

3.10.2 Supplementary Items

1001 Area of Aquaculture According to Type of Site (for the holding)

- Land-based
  - — Arable land
  - — Non-arable land
- Inland open water
- Coastal and marine waters

A.297. Area of aquaculture refers to the area of land under water used for aquaculture. This means the surface area of the pond, paddy field, lagoon, estuary, irrigation canal, or the sea used for aquaculture. The area figure should include supporting structures such as pond banks and floating structures of cages. The area of land-based aquaculture-related facilities such as

hatcheries, storage buildings, fish processing facilities, laboratories and offices, should not be included. The area should include land owned by the holding as well as bodies of water rented from others for use for aquacultural purposes. Such bodies of water could include parts of rivers, lakes, reservoirs, dams, canals, lagoons/estuaries, bays/coves, or the open sea. The aquacultural area should refer to the area of the aquacultural facility on the body of water – for example, the total area of the pen or cage network in the water. Some holdings may have very small area of aquaculture.

A.298. Land-based aquaculture is aquaculture practiced in rice fields, ponds, tanks, raceways and other land areas on the holding. Economies may need to develop procedures to distinguish between land-based and open water aquaculture for some water bodies such as ponds. The split into arable and non-arable land is intended to determine what part of the land-based aquaculture is practiced on land that is also used for crop production. Examples of non-arable land are saline-alkaline lands and wetlands. Refer to paragraph A.38 for the definition of arable land.

A.299. Inland open water includes dams, reservoirs, lakes and rivers. Coastal and marine waters include lagoons, estuaries, shallow and open seas, bays and coves, including inter-tidal mudflats.

A.300. The reference period for data on area of aquaculture is the census reference year.

1002 Area of Aquaculture According to Type of Production Facility (for the holding)

- Rice-cum-fish culture
- Ponds
- Pens, cages and hapas
- Tanks and raceways
- Floating rafts, lines, ropes, bags and stakes

A.301. Rice-cum-fish culture is the use of land for the culture of both rice and aquatic organisms. One form of rice-cum-fish culture is the introduction of brood-stock or seed into flooded paddy fields, often modified for aquacultural purposes. Another form of rice-cum-fish culture is where rice and fish are raised on the same land in different seasons. Fishing associated with fish from the wild that enter paddy fields during flooding is not included.

A.302. Pond culture is the breeding or rearing of aquatic plants or animals in natural or artificial enclosures. Pond culture is usually carried out in stagnant waters with periodic water exchange or water flushing through inlets and outlets. Sometimes, large ponds are used in association with cages or hapas. Often there is some integration between crops, livestock and pond culture, as in fish-cum-vegetable culture or fish-cum-animal husbandry.

A.303. Pens, cages and hapas are net enclosures used for rearing aquatic animals or plants in lakes, rivers, reservoirs or the open sea. Pens are fixed by frameworks made of metal, plastic, bamboo or wood. Cages are held in place by floating structures. Hapas are simple net enclosures suspended by stakes in the four corners in open water bodies.

A.304. Tanks and raceways are fixed structures used for raising aquatic animals or plants. They are normally built above ground and can be made of bricks, concrete or plastic. Tanks are small round or rectangular structures, whereas raceways are long, narrow structures.

A.305. Floating rafts, lines, ropes, bags and stakes refer to the aquacultural practice based on these facilities, commonly used for the cultivation of shellfish and seaweed.

A.306. The reference period for data on area of aquaculture is the census reference year.

1003 Type of Water (for the holding)

- Freshwater
- Brackish water
- Saltwater

A.307. This item refers to whether aquaculture on the holding was carried out during the reference year using water of the above types. There may be more than one type of water used on a holding. The type of water is usually closely related to the type of site in Item 1001.

A.308. Freshwater refers to reservoirs, rivers, lakes and canals, with consistently negligible salinity. Brackish water refers to waters with appreciable salinity but not to a constant high level. It is characterized by fluctuations in salinity due to regular influxes of freshwater and seawater, such as in estuaries, coves, bays and fjords. Enclosed water bodies in which salinity is greater than freshwater but less than seawater are also regarded as brackish. Saltwater (or marine water) refers to coastal and offshore waters where salinity is high and is not subject to significant daily or seasonal variation.

1004 Sources of Water for Aquaculture (for the holding)

- Rain-fed
- Groundwater
- Rivers/canals
- Lakes/reservoirs
- Dams
- Estuaries/lagoons
- Coves/bays/sea

A.309. This item refers to whether water for aquacultural production on the holding during the census reference year was obtained from the above sources. There may be more than one source of water used for aquaculture on a holding. The source of water is usually closely related to the type of site in Item 1001. Economies may wish to adapt these categories to suit local conditions.

1005 Type of Aquacultural Organism Cultivated (for the holding)

- Freshwater fish
- Diadromous fish
- Marine fish
- Crustaceans
- Mollusks
- Other aquatic animals
- Aquatic plants

A.310. This item refers to which of the above types of aquatic organisms were cultivated on the holding during the census reference year. More than one type of organism may be cultivated on a holding. The classification refers to the type of aquatic animal or plant

cultivated, not the type of aquacultural product generated. Thus, pearl production is shown under “Mollusks”.

A.311. The main types of freshwater fish are carps and tilapias. Diadromous fish are fish that can live in both fresh and seawater, such as trout, salmon, eels and sturgeon. Marine fish include flounder, cod and tuna. Crustaceans are aquatic animals with hard shells, such as crabs, lobsters and shrimps. Mollusks are animals belonging to the phylum Mollusca, including abalones, oysters, mussels, scallops, clams and squids. Other aquatic animals include frogs, crocodiles, alligators, turtles, sea-squirts and sea urchins. Aquatic plants include seaweed and lotus.

3.11 THEME 11: FORESTRY

3.11.1 Core Items

0015 Presence of Forest and Other Wooded Land on the Holding

A.312. Presence of forest and other wooded land refers to whether such forest and other wooded areas are present on the land making up the agricultural holding. Refer to paragraphs A.35 & A.36 for the definition of forest and other wooded land. The reference period is the day of enumeration.

A.313. Often, holdings with forest and other wooded land are identified from holdings with land use "forest and other wooded land" in Item 0007. This is based on the concept of main use of the land. Some holdings have land not classified to land use "forest and other wooded land" that contains groups of forest trees or other wooded plants satisfying the criteria for "forest and other wooded land" in terms of tree height and crown cover. For example, "land under permanent meadows and pastures" may also contain forest trees and other wooded plants more than five meters in height with crown cover of more than 10%. To identify all holdings with forest and other wooded land, data on secondary land use are needed.

3.11.2 Supplementary Items

1101 Area of Forest and Other Wooded Land as Primary Land Use (for the holding)

- Forest
- Other wooded land

A.314. The total area of forest and other wooded land as a primary land use is given in the land use classification in Item 0007. Item 1101 sub-divides this total into its two components.

1102 Area of Forest and Other Wooded Land as A Secondary Land Use on Agricultural Land (for the holding)

- Forest
- Other wooded land

A.315. Area of forest and other wooded land as a secondary land use on agricultural land is the area of agricultural land with forestry and other wooded land as a secondary land use. Agricultural land covers arable land, land under permanent crops and permanent meadows and pastures (see paragraph A.38). The reference period is the day of enumeration.

1103 Main Purpose of Forest and Other Wooded Land (for the holding)

- Production
- Soil and water protection
- Multiple use
- Other

A.316. This item relates to all forest and other wooded land on the holding, including forest and other wooded land as a secondary land use on agricultural land (see Item 1102). Main purpose is assessed in relation to an extended period, usually the census reference year.

A.317. Production refers to the production and extraction of forest goods, including both wood and non-wood forest products such as oils, leaves and bark. Other includes forest/other wooded land with no specific function.

1104 Whether Agro-Forestry is Practiced (for the holding)

A.318. Agro-forestry is a sustainable farm management system in which trees and other wooded plants are purposely grown on the same land as agricultural crops or livestock, either concurrently or in rotation. Agro-forestry is characterized by the existence of both ecological and economic interactions between the different components. Agro-forestry includes agro-silvicultural (trees and crops), silvo-pastoral (trees and livestock), and agro-silvo-pastoral (trees, crops and livestock) systems.

A.319. Agro-forestry refers to specific forestry practices that complement agricultural activities, such as by improving soil fertility, reducing soil erosion, improving watershed management, or providing shade and food for livestock. Just growing trees on agricultural land is not considered agro-forestry. Economies need to develop their own procedures to collect these data. Some may wish to collect data on specific agro-forestry activities. The reference period for agro-forestry data is the census reference year.

3.12 THEME 12: MANAGEMENT OF THE HOLDING

Supplementary Items

1201 Identification of Sub-Holdings (for the holding)

1202 Identification of Sub-Holders (for the holding)

A.320. A sub-holding is a group of agricultural activities on the holding managed by a particular person in the holder's household. A sub-holder is a person responsible for managing a sub-holding. Refer to paragraphs 3.42–3.52 (FAO.2005) for the definitions of sub-holder and sub-holding and a discussion of data collection issues for these items.

1211 Sex of Sub-Holder (for each sub-holding)

1212 Age of Sub-Holder (for each sub-holding)

A.321. A census supplementary module on management of the holding usually includes data on demographic and social characteristics of household members (Theme 07) and economic activity of household members (Theme 08). Once the sub-holder is identified, he/she can be linked to the Theme 07 items to provide information on his/her characteristics, especially sex (Item 0711) and age (Item 0712).

A.322. Data on other characteristics of the sub-holder are usually also available from the Theme 07 and Theme 08 items, and may be useful for agricultural census analysis. This includes: relationship to household head (Item 0713); marital status (Item 0714); educational attainment (Item 0715); activity status (Item 0801); status in employment of main job (Item 0811); occupation of main job (Item 0812); time worked in main job (Item 0813); and time worked on the holding (Item 0814).

1213 Area of Crops Managed for Each Crop Group (for each sub-holding)

1214 Number of Livestock Managed for Each Livestock Group (for each sub-holding)

A.323. Area of crops managed refers to the area of the particular crop group under the control of the sub-holder. This relates to that part of the crop area in Item 0301 (temporary crops) and Item 0311 (permanent crops) that is under the control of the sub-holder. This refers to the area harvested during the reference year for temporary crops, or the current area for permanent crops.

A.324. Crops should be categorized into several groups suitable to domestic conditions, based on the crop classification given in Appendix 3. One possible grouping is:

- Grain crops
- Vegetable crops
- Other temporary crops
- Permanent crops

A.325. Number of livestock managed refers to the number of livestock managed by the sub-holder. This relates to those livestock in Item 0013 that are under the control of the sub-holder. This usually refers to the livestock numbers on the day of enumeration.

A.326. For reporting of Item 1214, livestock should be suitably grouped, based on the livestock classification in Appendix 5 (FAO, 2005). One possible grouping is:

- Large ruminants and equines
- Other animals
- Poultry
- Other

A.327. The method of collecting crop and livestock data for sub-holdings and sub-holders will depend on local conditions and the existing data collection methodology for crops and livestock. One method for crops is to identify all the plots of land making up the sub-holding, and collect data on the area of crops harvested for each plot. This approach may be suitable where economies already collect crop data at the plot level; otherwise, it may add complexity to the data collection operation.

A.328. Usually, it is better to collect the sub-holding/sub-holder data separately from the main crop and livestock data, by asking specific questions about the type of crop and livestock activities carried out under the control of the sub-holder. The crop and livestock data can be reported in broad groups as shown in paragraphs A.324 & A.325.