# Survey methods for the Enumeration of Nomadic and Semi-Nomadic (Transhumant) Livestock

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## ABSTRACT

Despite the growing importance and contribution of the livestock sector to the economy of many countries, statistical data on the sector remains weak and surrounded with large uncertainties. Even the total number of pastoralists in the world is not known within any degree of confidence. Data on nomadic and semi nomadic livestock is even less reliable given the specific challenges related to collecting data on this type of livestock since standard survey methods cannot be easily applied. Nomadic and transhumant pastoralists move their animals according to the availability of fodder resources and tend to inhabit relatively remote and inaccessible areas, which are major constraints on the conduct of conventional field surveys. Special attention is therefore required to devise appropriate methods for enumerating nomadic and transhumant livestock.

FAO's previous guidelines on collecting livestock data (FAO, 1992) included a review of methods for enumeration of nomadic livestock, but this was published over twenty years ago. Since then, new methods of assessing livestock resources and production parameters have been developed and new tools have become available for geo-referencing, recording and analyzing data as well as computer software programmes for data capture, checking, analysis and display have also greatly improved.

In light of the importance of nomadic livestock for many countries, the lack of a document synthesizing the existing approaches and in order to reflect new methods and tools, the FAO Global Strategy to Improve Agricultural and Rural Statistics has developed new guidelines on collecting statistics on nomadic and transhumant livestock. The guidelines address the methodological and operational challenges to enumerating nomadic and semi-nomadic livestock (GSARS, 2016). This paper draws on findings and guidance provided in these guidelines.

**Keywords:** Nomadic and transhumant livestock, ground and aerial survey, agricultural census

## PAPER

### 1. Introduction

In many developing countries, livestock production is one of the fastest growing components of agriculture and, as economic development progresses, is expected to become the largest contributor to the sector. Information on livestock producers and their animals is thus essential to the design, implementation, monitoring and evaluation of socially desirable interventions in the sector, including selective breeding, animal health, improved feeding, processing and marketing policies and investments.

The total number of pastoralists in the world is not known within any degree of confidence, because of inconsistencies in definitions and uncertain figures, but has been variously estimated at 20 million pastoral households (de Haan et al., 1997; referred to in Blench, 2001); 180.7 million individuals - pastoralists (Thornton et. al., 2002); and 200 million individuals - pastoralists (Rota and Sperandini, 2009). Estimating the number of nomads has been even less certain, with a commonly quoted figure about 30-40 million individuals. This figure seems to come from an estimate made at the latest in 1995 and numbers are likely to have fallen since then. ("Nomads: the facts". New Internationalist. Oxford, UK. 5 April 1995. Available at: http://newint.org/features/1995/04/05/facts/).

### 1. Issues to be addressed for enumerating nomadic and semi-nomadic livestock

Where agricultural households are settled and farm specific areas of land, the locations of towns, villages and farms are known and mapped. In these areas, the implementation of agricultural censuses or surveys – including on livestock – is a relatively straightforward process of organisation of statistical survey. Where livestock producers are transient pastoralists, standard survey methods of agricultural enumeration cannot be easily applied. Nomadic and transhumant pastoralists move their animals according to the availability of fodder resources and tend to inhabit relatively remote and inaccessible areas, which are major constraints on the conduct of conventional field surveys. Special attention is

therefore required to devise appropriate methods for enumerating nomadic and transhumant livestock,.

FAO's previous guidelines on collecting livestock data (FAO, 1992) which included a review of methods for enumeration of nomadic livestock, were published over twenty years ago. Since then, new methods of assessing livestock resources and production parameters have been developed; and new tools have become available for geo-referencing, recording and analysing data. Computer software programmes for entering, checking, analysing and displaying data have also greatly improved. A review of existing literature shows that the enumeration of nomadic and semi-nomadic population or livestock is discussed in several documents and research papers. However, there is no single document holistically synthesising the existing approaches. In light of its importance for countries, and in order to reflect new methods and tools, the FAO Global Strategy to Improve Agricultural and Rural Statistics has included the development of new guidelines on collecting statistics on nomadic and transhumant livestock as a priority topic in its research programme, addressing the methodological and operational challenges to enumerating nomadic and semi-nomadic livestock (GSARS, 2016).This paper draws on findings and guidance provided in these guidelines.

## 2. Types of surveys[1]

In general, two types of surveys (or combination of the two types) can be used to enumerate nomadic and transhumance livestock: (i) ground surveys and (ii) aerial/satellite surveys. Each method has prerequisites, advantages and disadvantages that are summarised in Table 1.

**Ground surveys** methods are mainly derived from techniques of enumerating nomadic people as used in population censuses. In fact, collecting data on nomadic and transhumant livestock needs a good knowledge of the population who raise that category of livestock. Ground surveys are implemented through two main ways:

- First, animals can be counted on **enumeration points** which are sites where animals congregate. There are several types of enumeration points commonly used, such as watering points, vaccination points, dip tanks and spray races, temporary seasonal camps, stock routes and livestock markets. It is also possible in some situations to create specific enumeration points for the purpose of the survey. Often different type of enumeration points are used for the enumeration of pure nomadic livestock and of transhumant livestock. In the case of livestock census of Niger 2004/5, the watering points were used as enumeration points for nomadic (?) and internal transhumant livestock, and stock routes (transhumance corridors) were observed for the external transhumant livestock.

- Secondly, as in some countries nomadism and transhumance are practiced by some specific **ethnics groups or clans**, livestock enumeration can be done with the support of ethnic group/clan leaders and family networks to locate livestock by identifying and locating temporary seasonal camps of group members. The enumeration is then organised by visiting these camps. The basic conditions for using this approach are given in Table 1.

**Aerial surveys** are more suitable and effective for large survey areas and in areas that are difficult to access, including desert environments. Most of the aerial survey methods used for enumeration of nomadic livestock are derived from the techniques used by wildlife biologists to estimate population size of wild animals. A large number of publications can be found in the literature on the use of these methods. ILCA (1981) discusses these methods and their application to livestock, wildlife and land-use surveys.

Aerial surveys can be implemented in various ways:

- Low level aerial surveys, which are usually done from aircraft flown at between 300-1,000 feet (100-300 meters) above the ground, are ideally suited for coverage of extensive, remote areas, which are inaccessible by other means.

- Drones, which are relatively cheap and lightweight, are starting to be used for data collection in relatively remote areas. They can be fitted with video or still cameras for livestock enumeration purposes. The major limiting factor at present is flight duration which is very short now.

- An additional method of survey is reliance upon satellite imagery. Today, this is widely available and, in the absence of reliable maps, can be an effective substitute in planning and implementing field data collection for livestock enumeration. Satellite imagery provides a broad overview of the landscape and land cover, and can be useful in locating tracks, settlements and water sources, as well as updating existing maps. For the time being, such imagery is limited in terms of enabling animals to be counted.

[1] An indicative decision tree is provided in annex

**Combining aerial and ground surveys**

Generally, when implementing aerial surveys, it is necessary to conduct complementary ground surveys to address some of the disadvantages of aerial survey methods such as impossible distinction between sheeps and goats, which can only be recorded as small ruminants; as well as between donkeys, mules and horses, all recorded as equines. Cattle can only be distinguished by colour type. A ground survey is necessary to assess breeds, and herd age and sex structure (Ethiopia, nomadic livestock survey in Somali Region, 2004).

**3. Census or sample survey?**

In case of ground surveys, the first step is to establish a complete listing of all enumeration points for the selected type and/or ethnic groups or clan to build a reliable national sampling frame for data collection. The second step is to decide between implementing a complete enumeration census or a sample survey. Where possible the complete enumeration for nomadic and especially for cross-border transhumant livestock is preferred.

In case sampling is necessary, e.g. because of operational, financial or timing constraints, a stratification would be useful, depending on the availability of additional information. The stratification would reduce statistical variation and improve the precision of estimates. The strata may be the different categories of enumeration points in the selected type or administrative areas. Some strata may be completely surveyed and a sample of enumeration points may be selected for others.

**4. Sampling design**

4.1 Ground surveys

Sampling enumeration points for transhumant and nomadic livestock is quite challenging because of the mobility of animals. The calculation of the probabilities of selection (used for weight estimation) may be complex and the information needed for the calculus may be difficult to collect in the field. In most countries, a stratified simple random sampling may be suitable when it is necessary to sample enumeration points. Depending on the number of enumeration points and their geographical dispersion, a multi- stage sampling may be used to reduce the cost of the survey. Here the estimation of the probability of selection of each animal is complex. More details sampling and estimation issues are available in (GSARS, 2016).

4.2 Aerial surveys

There are two main methods of assessing livestock populations from the air: total aerial counts and sample counts. A total aerial count of animals in an area can be obtained by flying a series of closely spaced, parallel flight lines with overlapping observation strips, or by a circular "cork-screw" flight path of decreasing radius over the area of interest (see Figure 1). This flight pattern should cover the whole area with no gaps between the flown patterns.

Four main methods of sampling livestock populations from the air are used Systematic Reconnaissance Flights (SRF), Stratified Random Aerial Transects (SRAT), Aerial Quadrat Sampling (AQS) and Aerial Block Sampling (ABS);. For more information on these methods, refer to (GSARS, 2016). The total number of animals is calculated by estimating the density of animals in the sampled area and then the total number of animals is calculated by multiplying this density with the total area of the survey.

The most common aerial sampling method applied for enumerating nomadic livestock is the Systematic Reconnaissance Flight (SRF). The Central Statistical Agency of Ethiopia used the SRF in 2003 to conduct a livestock aerial survey (Central Statistical Agency, 2004). In SRF surveys, a series of parallel flight lines are flown at equal distance from each other across the designated area (Norton-Griffiths, 1978; ILCA, 1981; Clarke, 1986). Each flight line is divided in sectors equal in ength to the flight line spacing to create a grid over the entire area (see Figure 1 ). Within each strip flown, only a part of the area is counted.

**Figure 1 - Total Aerial Count Patterns; SRF Sample Coverage**

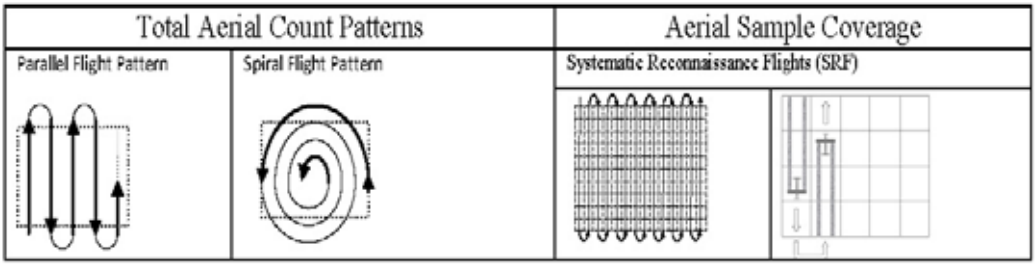

**Table 1 - Prerequisites, Advantages and Disadvantages of Survey Methods**

| Prerequisites | Advantages | Disadvantages |
|---|---|---|
| **Ground Survey - Water Points, Vaccination Points, Dipping/spraying points Example: Mali Survey 2001** | | |
| Requires complete list and map of all water or vaccination or dipping/spraying points in enumeration area. | • Animals can be easily seen and counted when coming to water or vaccination or dipping/spraying points where enumerators can be located;<br>• Logistically simple and easy to organise. | • Frequencies vary with species and location;<br>• Animals brought not necessarily nomadic/ transhumant;<br>• In some situations can be difficult to avoid double counting;<br>• Young stock may be excluded;<br>• Additional information/surveys required to determine watering frequencies/ to assess proportions vaccinated / determine proportion dipped/sprayed and proportion of nomadic/ transhumant animals to estimate population size. |
| **Ground Survey - Ethnic Groups/Clans Example: Ethiopian Afar Region Survey 2004** | | |
| Prior agreement and full cooperation of all group members; and list and map of all camp locations in enumeration area. | Involvement of Group/clan leaders in survey planning; in identifying and locating all members facilitates information collection. | • Assumes that clan leadership hierarchy know camp site locations of all members;<br>• Areas may be very large, exact locations may not be known;<br>• Some pastoral areas are shared by more than one group/clan, so more than one set of leaders may need to be involved. |
| **Ground Survey - Stock Routes Example: Niger transhumant corridors Survey 2004/5** | | |
| Complete list and map of all stock routes in enumeration area; and cooperation of herder to channel animals through check points. | • Can be good indicator of numbers moving from one area to another;<br>• Animals pass along stock route where enumerators can be located. | • May be many routes;<br>• Routes not always well defined;<br>• Often multiple tracks;<br>• May change from year to year;<br>• Not all animals use same route;<br>• Difficult to count large herds of moving animals. |
| **Aerial Survey - Systematic Reconnaissance Flight; Ethiopian Somali Region Survey 2004** | | |
| Preferably has clearly defined boundaries visible from the air: coastlines; mountain ranges; rivers; roads. | • Good for large, inaccessible areas, with no reliable ground counting frames;<br>• No prior assumption with regard to livestock distribution; | • Cannot distinguish between sheep and goats - recorded as small ruminants ;<br>• Cannot distinguish between donkeys, mules and horses;<br>• Can only distinguish cattle colour types .<br>• Requires ground survey to determine ratio/ herd age and sex structure |
| **Aerial Survey – Stratified Random Aerial Transects** | | |
| Has clearly defined boundaries visible from the air. | • Good for large, inaccessible areas, with no reliable ground counting frames | • In addition to the above, it assumes that identified strata are relatively homogeneous with regard to livestock distribution is concerned |
| **Aerial Survey-Aerial Quadrat Sampling and Aerial Block Sampling** | | |
| Has clearly defined boundaries visible from the air. | • In block and quadrat sampling, the aircraft makes as many passes as are required which can facilitate counting of animals. | • Suffer from boundary effects, (difficult to decide whether an animal is within or outside of the sample unit) particularly for quadrat sampling<br>• Blocks and quadrats tend to accentuate sampling error . |

## 5. What is the most appropriate way of counting animals?

In case of ground surveys, animals can be enumerated by physical inspection in herds and flocks (direct observations), or from the numbers reported by informants (interviews). The first option is the best in order to avoid declaration biases. Enumerators must count animals themselves by using various tools: hand tally or counter (single or multiple counters), photographs, etc. In order to avoid double counting, the counted livestock may be marked and an enumeration certificate may be provided to herders after counting. The second option of enumeration consists in using questionnaires to collect the number of livestock through the herders declaration. Some issues have to be taken into consideration: recall period should be different from large ruminants (12 months) and small ruminants (6 months), the herder is not always the owner, and herders are sometimes reluctant to provide accurate information. These issues may be sources of important declaration biases. It is thus important to select a sample of herds for a supplementary direct counting of livestock in order to correct these biases. In case of aerial survey, animals are counted and recorded during flight. In addition, photographs are taken of larger herds, for subsequent verification and correction of observer bias. Instead of having teams of people in a low flying aircraft, cameras can be installed that take photographs at regular intervals. Aerial photographs may be used to check the visual counts and correct for observer bias.

The information collected during a livestock enumeration depends very much on national and local circumstances and on the purposes of the survey. Potential tools for livestock enumeration, field data collection, analysis and presentation of results have greatly improved in recent years, with the advent of hand-held navigation devices, more powerful computers and general advances in Information Communication Technology (ICT). For example, there is an increasing use of Computer-Assisted Personal Interviewing (CAPI) tools in data collection on livestock that replace the Paper-and-Pen Interview (PAPI). Recording the location can be done manually using either dedicated GPS devices or using an add-on GPS app for smartphone or tablet (when CAPI data collection method is used).

An analysis of field data collection costs considering different methods implemented in tropical and sub-tropical countries shows variations between countries (table 2). The costs have been adjusted for inflation

and converted to Purchasing Power Parity (PPP) values. The highest cost per animal counted was in Jordan at USD 0.74, which may be due to the building of specific facilities at which the animals were counted. The next highest was the aerial survey in Ethiopia at USD 0.47 and this is undoubtedly because of the use of aircrafts which require specialised equipment and highly trained staff. The remaining enumerations for which costs are available display a cost per animal counted that is much lower than registered in Jordan or for the aerial survey, in the order of 10 per cent per animal. The cost per animal counted ranges from US$ 0.06 to US$ 0.02. However, these figures, can only be considered as indicative.

**Table 2 - Comparison of the costs of enumeration of nomadic/transhumance livestock**

| Country | Year | Method | Total cost (USD) | Total nomadic / transhumance animals counted | Estimated total nomadic / transhumance population | Cost per animal counted (USD) | Cost per animal in the estimated population (USD) |
|---|---|---|---|---|---|---|---|
| Afghanistan | 2002 | Census: village visits | No cost given | Unclear as many may be sedentary | | | |
| Ethiopia-Afar | 2004 | Stratified sample: household visits | 312,416 | Not clear | 9,014,365 | Cannot calculate | 0.03 |
| Ethiopia-Somali | 2004 | Aerial: 3.5% Systematic sample | 223,453 | 477,694 | 13,648,408 | 0.47 | 0.02 |
| Jordan | 1991 | Census: Constructed locations | 2,476,616 | 3,346,000 | 3,346,000 | 0.74 | 0.74 |
| Mali | 2001 | Census: water points | 241,535 | 4,193,848 | 4,193,848 | 0.06 | 0.06 |
| Mongolia | 2012 | Ground: 33% stratified sample | 277,976 | 13,640,000 | 40,920,000 | 0.02 | 0.01 |
| Niger | 2004-5 | Stratified sample: water points and transhumance routes | No cost given | Not given | 10,644,899 | | |
| Nigeria | 1992 | Aerial: 5% systematic sample | No cost given | | | | |

## 6. Conclusions

The challenges to obtaining reliable information about nomadic livestock can be addressed using various approaches according to local circumstances and requirements. Also the advent of hand-held navigation devices, more powerful computers and general advances in Information Communication Technology (ICT) in recent years have greatly improved tools for livestock enumeration, field data collection, analysis and presentation of results. Different country experiences show that a careful analysis of country s conditions can allow the selection of the most suitable method for generating data on nomadic and semi nomadic livestock. Ground surveys have been used in Mali and Niger (ground surveys using water points and transhumance routes), Mongolia (stratified sample survey), Jordan (complete enumeration of designated concentration areas) and Bolivia (stock routes). Aerial surveys have been used in Ethiopia and Nigeria (aerial survey complemented by ground survey).

The main conclusion is that there is no universally applicable method of enumeration of nomadic and transhumant livestock in all country conditions. The available methods should be carefully analysed in the light of the country peculiarities, resource and time constraints in order to choose the optimal approach.

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## Annex - Indicative decision tree