



# The Importance of Wild Meat in the Global South

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## ABSTRACT

Information on the economic importance of wild meat to rural people is mainly based on small case studies conducted in limited geographical areas with high hunting intensities, which impede generalization of results. Through a one-year quarterly income survey of 7978 households in 24 countries across Latin America, Asia, and Africa, we show that 39% of the sampled households, by extrapolation representing ~150 million households in the Global South, 'harvest' wild meat. On average, wild meat makes up 2% of households' income of which own consumption accounts for 89%. Reliance on wild meat is highest among the poorest households and inversely related to their reliance on domestic animal income. Seasonally, reliance on wild meat is inversely related to other incomes, suggesting a gap filling function. The fact that hunting is of low economic importance but widespread and mostly for subsistence suggests that wild meat is important in rural households' diets. Through an approximated yield-effort curve estimation, we show that hunting appears economically sustainable in 78% of the observed communities although in most cases this might represent post-depletion sustainability. Our results imply that the effectiveness of wildlife conservation efforts is likely to be enhanced if rural food security is simultaneously improved.

## 1. Introduction

The UN's Zero Hunger Challenge goal to eliminate global hunger by 2025 requires year-round access to adequate and nutritious food for all from environmentally sustainable food systems (UN, 2016). This includes access to environmental products (non-cultivated products from forests and other non-agricultural environments). A recent global study documented that these products provide 28% of total subsistence and cash income in rural households in developing countries (Angelsen et al., 2014). An increasing number of case studies focus specifically on wild meat (also called bushmeat) and its importance to rural households in the Global South for food and nutritional security and as a source of income (CBD and WHO, 2015). The sustainability of current 'harvest' rates is, however, doubtful in many locations as indicated by empirical evidence that links persistent decline and local extinction of numerous species across Africa, Asia, and Latin America to hunting, and especially commercial hunting supplying urban markets (Robinson and Bennett, 2000; Milner-Gulland et al., 2003; Ripple et al., 2016). Particularly, primate and larger herbivore populations appear threatened by overhunting (Dirzo et al., 2014; Ripple et al., 2015). In many locations, depletion of wildlife populations has resulted in so-called 'empty forests' (Redford, 1992; Wilkie et al., 2011). Depletion of wildlife has negative repercussions not only for rural households who depend on this source of nutrition and income but it also affects the habitat itself as targeted

species often perform important and irreplaceable ecosystem functions (Kurten, 2013). Overhunting may, thus, change plant community composition, forest structure and productivity, thereby potentially reducing the long-term viability and service delivery of ecosystems (Galetti and Dirzo, 2013). Accordingly, policies and management strategies that lead to practices, which balance objectives of conserving biodiversity while ensuring human food security and income are urgently needed.

Yet, at least two overall limitations impede our understanding of the role of wild meat in rural livelihoods. First, knowledge on the importance of wild meat hunting is based on relatively few case studies with small samples, limited geographical coverage as well as variation, and methodological pluralism, which constrains synthesis of their results. Study sites with high levels of hunting are often purposefully selected (Schulte-Herbrüggen et al., 2013) and available empirical evidence is therefore unlikely to be representative of hunting in most locations. Thus, although wild meat reputedly is an essential source of protein and income for hundreds of millions of rural people in developing countries (Brashares et al., 2011), hunting prevalence and people's reliance on wild meat at the scale of the Global South has yet to be examined. Second, hunting is claimed to be increasingly commercially driven (Fa and Brown, 2009) with the trade valued at several billion dollars annually (Brashares et al., 2011) but it is unclear whether wild meat cash income is more important to rural livelihoods than

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subsistence income and whether bushmeat trade merely provides a safety net or fills income gaps in times of unexpected or recurrent economic hardship. Finally, a generally agreed-upon assumption is that wild meat hunting in the tropics is often unsustainable (van Vliet et al., 2015). However, sustainability has rarely been examined outside areas of known high levels of hunting, or high conservation significance due to presence of threatened or otherwise iconic species and mainly through problematic indirect biological indicators (van Vliet et al., 2008; Weinbaum et al., 2013). Furthermore, evaluations of the economic sustainability of this form of production are virtually absent. Here we provide information and analyses to bridge these knowledge gaps using standardized household data enabling evaluation across the Global South. We examine household level determinants of hunting and the temporal structure of the data elsewhere (Nielsen et al., 2017; Nielsen, in prep.).

## 2. Methods

### 2.1. Data Description

We draw on global data from the Poverty Environment Network (PEN) (Angelsen et al., 2011) (downloadable from <http://www1.cifor.org/pen>) to assess the economic role of wild meat in rural household income. Data was gathered by 33 PEN researchers from January 2005 to May 2010 using a common standard survey instrument. To date, PEN constitutes the largest quantitative, global-comparative research project on environmental products and rural livelihoods and covers 7978 households with > 53,000 individuals from 333 villages in 58 sites in 24 tropical countries across Sub-Saharan Africa, Asia, and Latin America (Supplementary material, Table S1). Sites were selected to contribute country- or site-level variation in infrastructural development, remoteness, and habitat type, and communities within sites were selected for variation in distance to market, vegetation types, land tenure, local institutions, population density, ethnic composition, sources of risk, and levels of poverty. The nature or level of wild meat hunting was not a site selection criterion or a focus of PEN. Thus, data does not include information about wildlife population densities or species caught. Assessing the representativeness of the sites in relation to forest cover and population density, as two important indicators of development, reveals that sites are located along the full range of forest cover in the countries where surveys were carried out and largely also along the population density distribution (Dewi, 2011; Dewi and Belcher, 2012) (see Supplementary material). Hence, data stems from sites that are largely representative of non-coastal smallholder-dominated tropical and sub-tropical landscapes in the selected countries (Wunder et al., 2014). Although close to forests, the sites mainly constitute agricultural matrix areas of limited biodiversity value.

The PEN project applied standardized interview-based questionnaire surveys enabling detailed recording of all household income sources and local values of all environmental products collected from forests and other habitats across all sites. This involved detailed, quarterly recording of all cash and subsistence incomes from forests and other non-cultivated sources (environmental incomes), agriculture, livestock, wages, business, and other sources (incl. remittances and pensions). To minimize recollection bias and errors caused by seasonal variation, short recall periods of 1–3 months, depending on income source (1 month for wild meat and other environmental goods), were used in quarterly household visits distributed over one full year (Angelsen et al., 2014). While a shorter recall period may facilitate accuracy, it also increases the likelihood of missing products that are infrequently collected or limited to a short season. PEN instead used pre-developed lists of all relevant products and goods to aid respondent recollection and ensure wider temporal coverage. Income (net) was defined as value added of labor and capital less costs of purchased inputs (Angelsen et al., 2011). Amounts of all harvested products were converted to monetary values based on local market prices or average

own reported values per unit and using a range of valuation methods for products with thin or no local markets (Angelsen et al., 2011). Hence, both cash and subsistence income (as it is commonly denoted in PEN publications) were determined and analyzed. Subsistence income is defined as the local net monetary value of consumed products collected by the households. Focus group discussions were conducted in each community to describe the three most important environmental products, trends in the availability of these, institutions managing access to them, and to rank the three most important reasons for change in accessibility of these resources. Considering the sensitivity of information on hunting in some sites, all respondents were guaranteed anonymity in the survey. Respondents' trust and collaboration was furthermore encouraged by the long-term relations with the survey teams over the course of a year.

To allow inter-household comparisons across the entire sample, national currencies were converted to purchasing power parity (PPP) adjusted USD and income values calculated per adult equivalent unit (AEU). We considered wild meat harvesting as the successful hunting of wild animals for food and non-food purposes, including for own consumption, gifts and for trade as well as for medicinal or spiritual purposes (CBD, 2011). We focused on terrestrial mammals, birds, reptiles, and amphibians that commonly constitute the main sources of wild meat (Fa et al., 2005). We defined hunting households as those who obtained wild meat income in the survey period; prevalence of hunting as the percentage of households hunting; absolute wild meat income as the total annual net cash as well as subsistence income originating from wild meat; and reliance on wild meat as the share of wild meat income in total household income. Accordingly, reliance is here measured in terms of contribution to total household income. Mean reliance values were calculated as means of shares, not shares of means, and sample weights (denoting the inverse of the probability that an observation is included because of the sampling design) were used in calculating means.

### 2.2. Estimating the Global Importance

We estimated the population relying on wild meat and the turnover of wild meat trade in the Global South by extrapolating PEN data on prevalence of hunting, and absolute wild meat cash income for each country and continent (i.e. two estimates) based on UN data on rural populations (UN, 2014). We converted the UN data on rural populations to number of households based on the mean number of household members in the PEN sample for the respective country or continent for compatibility. The estimates depicted in the Supplementary material, Table S2 take departure in the countries included in the PEN survey (probability weighed site of country), whereas the estimates in Table S3 encompass all countries in Central and South America, Eastern, Southern and South-eastern Asia, and Sub-Saharan Africa (probability weighed site of continent). Our estimates represent the first empirically-derived estimates on the prevalence of bushmeat hunting in the Global South. However, they should be treated with caution as they are based on extrapolations from sites that are not strictly randomly distributed and do not represent a sampling intensity corresponding to land area or population density of the relevant countries, c.f. above. Furthermore, the sample sites do not include known locations with high levels of bushmeat hunting and trade due to the sampling strategy selected by the PEN survey.

### 2.3. Assessing Economic Sustainability

Wildlife population surveys were not included in the PEN survey and alone provides limited basis for evaluation of sustainability (Ling and Milner-Gulland, 2006; van Vliet et al., 2010, 2015). Constrained by the available data, we, therefore, applied a novel approach based on the theoretical relation between hunting effort and hunting yield from bio-economic equilibrium theory to assess the economic sustainability of

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