Prevalence, determinants and seasonal variation of food security among the Batwa of Kanungu District, Uganda

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Abstract

Climate change is projected to increase the burden of food insecurity globally, particularly among populations that depend on subsistence agriculture. Africa is projected to experience a disproportionate frequency of climatic events, including increased temperatures (2-4^{o}C), extreme drought, and unpredictable precipitation as a result of climate change. Africa's dependence on agriculture will make it particularly vulnerable to these impacts. Indigenous populations frequently face increased risk as a result of historical patterns of neglect by governments, colonialist legacies, lack of access to resources, ethnic discrimination, low employment, extreme poverty, and dependence on subsistence lifestyles. Indigenous peoples consistently experience lower levels of food security than their non-Indigenous counterparts, and are more likely to be dependent upon land-based resources. There is a lack of empirical or place-based research characterizing the extent to which Indigenous food security in vulnerable global regions is associated with climate change or weather. The Batwa Pygmies, a rural Indigenous population in southwestern Uganda, are one of the poorest populations in Africa, have a high burden of illness, and face both physical and social barriers accessing health care and education. Additionally, their reliance on agriculture and subsistence living, like elsewhere in rural Africa, results in a food system that is especially vulnerable to climate change impacts. My thesis estimates the prevalence, identifies determinants, and characterizes the lived experience of food insecurity and seasonal variation among the Batwa of Kanungu District, Uganda. In particular, I examined how food insecurity is measured and the extent to which it is impacted by seasonal variation among the Batwa, drawing on longitudinal data from quantitative surveys collected between January 2013 and April 2014, and supported by qualitative data collected during the summer 2014. The Batwa were homogenously food-insecure (97%). Our results suggest that variation in food

insecurity may be poorly reflected in household-level, or even community-level, analyses, and that variation and key predictors of food security – and therein appropriate intervention entry points – are likely occurring at the regional scale. Seasonal variation was identified as a significant predictor of food insecurity in both the quantitative and qualitative data. Most families experienced more difficulty in acquiring sufficient quantities of food and reported eating lower quality foods during the dry season. However, several factors mediated the impact of seasonal variation, including employment, wealth and community location. The findings support the role social factors play in mediating seasonal impacts on health outcomes, in this case food security. Further, food insecurity analysis should be considered scale-dependent, with increased use of multilevel modeling approaches to identify methodologically-appropriate and policy-relevant scales of analysis. This research is consistent with calls to treat climate associations with health outcomes as non-stationary and mediated by social sensitivity. Mixed methods research will be imperative within this context as a component of vulnerability assessment and climate change adaptation planning.

Resume

Il est anticipé que les changements climatiques vont engendrer un alourdissement du fardeau de l'insécurité alimentaire à l'échelle mondiale, et ce, particulièrement pour les populations qui dépendent de l'agriculture vivrière. On prévoit que l'Afrique sera affectée par une fréquence disproportionnelle d'évènements climatiques, dont des augmentations de température (2 à 4 °C), des sécheresses extrêmes et des précipitations imprévisibles. La dépendance de l'Afrique à l'égard de l'agriculture la rend particulièrement vulnérable aux effets de ces impacts. Les risques qu'encourent les populations autochtones sont d'autant plus importants, car ces groupes doivent composer avec des années de négligence gouvernementale, les legs d'un passé colonial, un manque d'accès aux ressources, la discrimination ethnique, un niveau de chômage élevé, la pauvreté extrême et leur dépendance envers une économie de subsistance. Les groupes autochtones éprouvent des niveaux de sécurité alimentaire invariablement inférieurs à ceux des populations non indigènes et ils sont plus souvent dépendants des ressources terrestres. Il y a par contre un manque de recherche empirique et d'études de cas portant sur l'impact des changements climatiques ou des conditions météorologiques sur la sécurité alimentaire des populations autochtones qui habitent les régions vulnérables du globe. Les Pygmées Batwas sont une population autochtone rurale du sud-ouest de l'Ouganda et ils forment un des groupes les plus pauvres de l'Afrique. En plus d'éprouver des taux importants de maladies, les Batwas font face à des barrières physiques et sociales qui les empêchent d'avoir accès à des soins de santé et à l'éducation. Par ailleurs, comme d'autres groupes ruraux en Afrique, leur dépendance à l'égard de l'agriculture dans un contexte de subsistance les rend particulièrement vulnérables aux effets des changements climatiques. Ma thèse estime la prévalence, identifie les déterminants et examine le caractère saisonnier de

l'insécurité alimentaire chez les Batwas du district de Kanungu. Elle étudie aussi l'expérience vécue des Batwas relative à cette insécurité. Par l'entremise de données longitudinales provenant de sondages quantitatifs réalisés entre janvier 2013 et avril 2014 et avec l'aide d'un complément de données qualitatives cueillies pendant l'été de 2014, j'examine les limites des mesures existantes de l'insécurité alimentaire et j'étudie l'impact des variations saisonnières sur la sécurité alimentaire des Batwas. De manière homogène, les Batwa vivent dans l'insécurité alimentaire (97 %). Nos résultats suggèrent que les variations dans l'insécurité alimentaire peuvent être inadéquatement représentées dans les analyses qui utilisent les ménages, ou encore les communautés, comme unités. Ils indiquent aussi qu'il est probable que la variation dans la sécurité alimentaire ainsi que ses déterminants principaux et, par conséquent, les points d'entrées appropriés pour les interventions se trouvent plutôt à une échelle régionale. Par ailleurs, les données quantitatives et qualitatives montrent que les variations saisonnières constituent un déterminant significatif de l'insécurité alimentaire. La majorité des familles ont davantage de difficulté à acquérir suffisamment de nourriture pendant la saison sèche. Ils disent aussi manger des aliments de moindre qualité durant cette période. Néanmoins, plusieurs facteurs peuvent modifier l'impact des saisons, dont l'emploi, la richesse et l'emplacement de la communauté. Nos trouvailles démontrent davantage le rôle des facteurs sociaux dans la médiation de l'impact des saisons sur les résultats en matière de santé. De plus, nous avançons qu'il faut considérer les analyses d'insécurité alimentaire comme tributaires aux échelles utilisées et faire un usage croissant d'approches de modélisation à niveaux multiples pour déterminer les échelles d'analyse méthodologiquement appropriées et pertinentes pour les politiques d'intervention. Les résultats de cette enquête sont aussi compatibles avec les appels pour concevoir les rapports entre les changements climatiques et la santé des populations comme non stationnaires et médiés par des

facteurs sociaux. Les méthodes mixtes deviendront impératives dans ce contexte, autant pour l'évaluation de la vulnérabilité que pour la planification de l'adaptation aux changements climatiques.

Preface and contribution of authors

This thesis has been written in manuscript style and consists of two manuscripts. These manuscripts have been prepared for submission in academic journals. I outline here the journals where each manuscript will be submitted, the co-author list and co-author contributions.

Manuscript 1: At what scales does food insecurity vary? A case study of highly food insecure Indigenous communities in SW Uganda

Authors: Kaitlin A. A. Patterson, Lea Berrang-Ford, Shuaib Lwasa, Didacus Namanya, James Ford, IHACC research team, Sherilee L. Harper

This manuscript is being prepared for submission to *Food Security*. This research is a part of the Indigenous Health and Adaptation to Climate Change (IHACC) project). The project assesses burden of illness among Indigenous populations in three countries: the Inuit (Arctic), Shawi (Peru) and the Batwa (Uganda). The IHACC principle investigators (Lea Berrang-Ford, James Ford, Shuaib Lwasa, Didicus Namanya, Victoria Edge, Cesar Carcamo, Alejandro Llanos) designed the broader study, and Kaitlin Patterson contributed to the food security questionnaire design. Data collection was conducted by Kaitlin Patterson and IHACC research team including all co-authors. Analysis and writing was done by Kaitlin Patterson with guidance, feedback and editing from Lea Berrang-Ford, Shuaib Lwasa, Didacus Namanya, James Ford and Sherilee L. Harper.

Manuscript 2: Seasonal variation of food security among the Batwa of Kanungu, Uganda

Authors: Kaitlin Patterson[a], Lea Berrang-Ford, Shuaib Lwasa, Didacus Namanya, James Ford, Fortunate Twebaze, Sierra Clark, IHACC research team, Sherilee L. Harper.

This manuscript is being prepared for submission to *Social Science and Medicine*. Kaitlin Patterson designed the study with feedback from Lea Berrang-Ford, Shuaib Lwasa, Didacus Namanya. Data collection was conducted by Kaitlin Patterson, Sierra Clark and Fortunate Twebaze. Coding and memoing were conducted by Kaitlin Patterson and Fortunate Twebaze. Analysis and writing was done by Kaitlin Patterson with guidance, feedback and editing from Lea Berrang-Ford, Shuaib Lwasa, Didacus Namanya, James Ford and Sherilee L. Harper.

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Acronyms

AIC - Akaike Information Criterion
AVPS – Adapted Vulnerable Populations Score
BCH – Bwindi Community Hospital
BDP – Batwa development Programme
BINP - Bwindi Impenetrable National Park
BLUPS – Best linear unbiased predictors
CBPR - Community-based participatory research
CDC- Centers for Disease Control and Prevention
FAO – Food and Agriculture Organization
FDG – Focus Group Discussion
FPP – Forest Peoples Program
HFSSM - Household Food Security Survey Module
ICC – Intra-class correlation
IFAD – International Fund for Agricultural Developent
IFPRI - International Food Policy research Institute
IHACC – Indigenous Health and Adaptation to Climate Chage
IPCC - Intergovernmental Panel on Climate Change
KI- Key informant
MDG – Millennium Development Goals
NGO - Non-Governmental Organizations
PCA – Principle component analysis
SSI- Semi-structured interviews
UOBDU – Ugandan Organization for Batwa Development in Uganda
USDA – United States Department of Agriculture
VPC – Variance partitioning coefficient
WFP – World Food Program
WHO – World Health Organization

Chapter 1: Introduction, aims & objectives

1.1 Introduction

"… Indigenous health is systematically worse in many respects than that of majority populations, particularly where through loss of land and other natural resources they are no longer able to maintain traditional livelihoods and sustain traditional culture, knowledge, and institutions. However, data are weak because of well recognised drawbacks to obtaining information in remote areas with scattered populations." (Ohenjo et al., 2006)

Climate change is expected to increase the frequency of climatic events with negative health impacts, including extreme drought, increased temperatures, and unpredictable precipitation (Costello et al., 2009; Godfray et al., 2010; Lobell et al., 2008; McMichael, Woodruff, & Hales, 2006; Patz et al., 2005; Patz, Grabow, & Limaye, 2014; St. Louis & Hess, 2008). The IPCC's most recent report states that "*health losses due to climate change induced under nutrition will occur mainly in areas that are already food insecure*" (2014). Africa is projected to experience a disproportionate number of climatic events, and its dependence on agriculture will make it particularly vulnerable (Adger, 2006; Lobell et al., 2008; Patz et al., 2005; Smit & Wandel, 2006). Food security is recognized as a key determinant of health in both developed and less developed regions; studies have demonstrated higher rates of poor health among populations experiencing both acute and chronic hunger (Cook et al., 2004; Costello et al., 2009; Gundersen, 2013; Kirkpatrick, McIntyre, & Potestio, 2010; Pelletier, Olson, & Frongillo, 2012; Rosegrant & Cline, 2003). Sub-Saharan Africa is one of, if not the most food insecure region in the world, and struggles currently with poverty and high rates of malnutrition.

Further stressors, including increased frequency of adverse climatic events, may surpass its ability to adapt (Adger, 2006; Adger & Kelly, 1999; Hertel, Burke, & Lobell, 2010; Smit & Wandel, 2006). Indigenous populations face an increased risk as a result of historical patterns of neglect by governments, colonialist legacies, systematic poor health, lack of access to resources, ethnic discrimination, low employment, extreme poverty, and dependence on subsistence lifestyles (Berrang-Ford et al., 2012; Ford, 2012; King, Smith, & Gracey, 2009; Lynn et al., 2013; Maldonado, Colombi, & Pandya, 2014; Ohenjo et al., 2006).

The Batwa Pygmies, a rural Indigenous population in southwestern Uganda, are at risk due to their environment and socio-political contexts (Balenger et al., 2005; Berrang-Ford et al., 2012; Clark et al., 2014; Harper, 2012; Jackson, 2002; Lewis, 2000; Lewnard et al., 2014; Namara, 2007; Tumushabe & Musiime, 2006; Warrilow, 2008; Zaninka, 2001). The Batwa are one of the poorest populations within Africa, have a very high burden of illness and face both physical and social barriers accessing health care and education (Berrang-Ford et al., 2012; Clark et al., 2014; Harper, 2012; Lewnard et al., 2014). Like many regions in rural sub-Saharan Africa, the Batwa rely on agriculture and subsistence living, and as a result their food system is especially vulnerable to climate change impacts (Alexandratos, 1995; Bogale & Shimelis, 2009; Chan, 1990; Devereux & Maxwell, 2001; Egeru, 2012; Fischer et al., 2005; Gregory, Ingram, & Brklacich, 2005; Hinrichs, 2013; Kotir, 2011; Magrath, 2008; Morton, 2007; Nelson et al., 2009; Osbahr et al., 2011; Tubiello & Fischer, 2007; Wossen & Berger, 2015). Despite this, there is a lack of research globally on Indigenous food security and health, and Indigenous populations' vulnerability to climate change impacts. This thesis contributes to the growing literature on place-based Indigenous research on food security and climate change, with implications for public health policy and local adaptation and intervention strategies.

1.2 Aim & objectives

This research aims to assess the role of seasonal variation in the prevalence, determinants and experiences of food insecurity among the Batwa of Kanungu District, Uganda.

The main objectives of this research were to:

1. Estimate the prevalence of food insecurity among the Batwa of Kanungu District.
2. Identify the determinants of food insecurity among the Batwa of Kanungu District.
3. Examine the scale at which food insecurity varies among the Batwa of Kanungu District.
4. Quantify, critically assess and characterize seasonal variation in Batwa food systems.

This thesis estimates the prevalence, identifies determinants, and characterizes the lived experience of food insecurity and seasonal variation among the Batwa of Kanungu District, Uganda. In particular, I will consider the how food insecurity is measured and the extent to which it is impacted by seasonal variation among the Batwa, drawing on longitudinal data from quantitative surveys (n=6 surveys) collected between January 2013 and April 2014, and supported by qualitative data collected during the summer of 2014.

1.3 Outline of thesis

This thesis has been written in manuscript style. The first chapter of provides an introduction and background to the research problem and outlines the aim and objectives. The second chapter is a literature review situating this study within the health geography field and providing a context for the two manuscript chapters. The third chapter is written in manuscript style and investigates the measurement, severity and scale of food insecurity among the Batwa (Objectives 1-3). The fourth chapter, also written in a manuscript style, quantitatively and qualitatively assesses the lived experience of food insecurity and seasonal variation among the Batwa (Objective 4). The fifth and final chapter discusses the main contributions of two manuscripts and reflects on the limitations and opportunities moving forward.

Chapter 2: Literature review

This research is guided by the principles of health geography, including the role of scale and place. My research questions are contextualized by literature comprising of three key subjects: food systems and food security, health and climate change, and the Batwa of Uganda. An overview of health geography will be presented followed by relevant literature on food security, health and climate change and the Batwa of Uganda.

2.1 Health geography

The term health geography emerged from 'medical geography' through increased recognition of health processes beyond the spatial distribution of disease or biomedical focus, encompassing a broader field examining the complex relationships between health and place (Asthana et al., 2002; Brown & Duncan, 2002; Brown, McLafferty, & Moon, 2009; Dummer, 2008; Giesbrecht et al., 2014; Rosenberg, 2015; Tunstall, Shaw, & Dorling, 2004). Similarly, health geography distinguishes itself from epidemiology by placing emphasis on how place impacts health, and how, in turn, health can influence place, whether it be natural, constructed or imagined (Cutchin, 2007; Rose, 2001; Schwartz, Susser, & Susser, 1999; Wakefield & McMullan, 2005). The role of place and space have been given more focus with the development of public and global health as research disciplines, and furthered by globalization and urbanization research (Asthana et al., 2002).

Health geography, as outlined by Kearns & Collins (2009), centers around three themes; place, health and wellbeing. It has been closely linked with the critical, holistic and methodological approaches of human geography (Bradshaw, 2001; Clifford & Valentine, 2003; Crang, 2005; Dyer & Demeritt, 2009; Flowerdew & Martin, 2005; Rosenberg, 2014). Place, it

can be argued, is the dominant component of geographical research (*Dictionary of Human Geography (5th Edition)*, 2009; Kearns & Collins, 2009). In medical geography, place has typically been measured through positivist or quantitative methods (i.e. space). Although quantitative methods can convey aspects of culture and lifestyle, they typically reflect the physical environment (Andrews et al., 2012; Fleuret & Atkinson, 2007). Health geography incorporates localities (geographical based factors), landscapes (combination of the perceived and built environment) and multilevel (quantitative assessment of health and place at different scales) approaches into its analysis of place (Gesler, 2005; Kearns & Collins, 2009; Meade, 2014; Rosenberg, 2014, 2015). The traditional view of health through a biomedical lens, while not the sole view, remains an important component of research.

Health geography approaches to health are similar to other social science disciplines; health is viewed as more than the absence of disease, but rather the realization of human potential (Andrews et al., 2012; Fleuret & Atkinson, 2007; Kearns & Collins, 2009; Sen, 1999; WHO, 1948). The concepts of place and health have been combined to create a more holistic positive goal of well-being (Andrews et al., 2012; Kearns & Collins, 2009; Kearns & Barnett, 2000). Kearns & Collins (2009) highlight that using wellbeing as a research focus has allowed geographers to investigate "… *the complex layerings of history, social structure, symbolism, nature, and built environment that converge at particular sites… [that] may enhance or corrode human wellbeing*". While the shift from medical to health geography has been concentrated on the effort to broaden our understanding of the relationships between place and health, key aspects like geographic location and spatial heterogeneity remain. Health geographers caution that while new concepts of space and landscape are important, key social determinants of health are spatially sensitive, including: income inequality, access to services and health care, historical

racism, social hierarchies, gender inequality, political structures, power dynamics and environmental exposures (Kearns & Collins, 2009; Kearns & Moon, 2002; Pearce, 2011; Rose, 2001; Schwanen & Atkinson, 2015).

Mixed methods have been utilised within health geography to enable researchers to assess wellbeing through a holistic approach. Health geography has a history of employing mixed methods, including multilevel and spatial modelling, geographical information systems (GIS), surveys, interviews, photo-voice, and community mapping (Andrews et al., 2012; Crang, 2005; Cromley & McLafferty, 2011; Duncan, Jones, & Moon, 1998; Dunn, 2013; Flowerdew & Martin, 2005; Robin Kearns & Collins, 2009; Moon, 2009; Parfitt, 2005; Parr, 2002; Rosenberg, 2015; Shaw, Dorling, & Mitchell, 2002; Valentine, 2005). The value of mixed methods (i.e. qualitative and quantitative) data collection and analysis has been recognized and employed by many fields in the social sciences and is gaining popularity in health research (Bradshaw, Wood, & Williamson, 2001; Bryman, 2006; Jick, 1979; Johnson, Onwuegbuzie, & Turner, 2007; Sale, Lohfeld, & Brazil, 2002; Sandelowski, 2000). Health geography's concepts of health and place (scale, geographical location) and use of mixed methods provide a useful framework to analyse the lived experience of food security and climate change and associated implications for the health of the Batwa in Kanungu District, Uganda.

2.2 Food systems & food security

A *food system* comprises the production, processing, distribution, preparation and consumption of food (Ericksen, 2008; Gregory et al., 2005). More comprehensive definitions of a food system include the food chain, outcomes of production and the interactions and cyclical relationships between human and biophysical environments (Ericksen, 2008; Vermeulen, Campbell, & Ingram, 2012). Food systems can become stressed by a number of factors,

including climate (drought, flooding), economic (price or demand increases, food shortages), or social (conflict, inequality, poverty). Stressors on a food system lead to increased difficulty in securing food at various scales (e.g. regional, community, household and individual). Food security is defined as "*all people, at all times, [having] physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*" by the FAO (1996). The definition outlined by the FAO goes beyond a supply approach; *availability*, *access* and *utilization* of food are highlighted with stability as an additional caveat (FAO, 1996). Food *availability* refers to consistent and sufficient quantities of food. Food *access* is important in addressing unequal distributions of food; lack of financial and social resources can be barriers to acquiring sufficient food (Bickel et al., 2000; FAO, IFAD, & WFP, 2013; Schmidhuber & Tubiello, 2007). Simply accessing nutritionally adequate and safe food is not sufficient as appropriate or traditional foods need to accessible in socially acceptable ways (Anderson, 1990; FAO, 1996). Food *utilization* focuses on biomedical outcomes of food insecurity (Ericksen, 2008). Food quality and quantity (i.e. sufficient calories, vitamins and nutrients) are all essential for a healthy diet (Bickel et al., 2000; FAO et al., 2013; Schmidhuber & Tubiello, 2007). Food insecurity can prevent households and individuals from meeting their daily intake requirements. Numerous negative health outcomes have been linked to food insecurity and poor diet, including malnutrition, stunting, wasting, delayed development, mental stress, and a weakened immune system, leading to greater risk of infection and chronic illness (Cook et al., 2004; Hamelin, Habicht, & Beaudry, 1999; McIntyre, Tarasuk, & Jinguang Li, 2007; Vozoris & Tarasuk, 2003). Poor health can, in turn, impact food insecurity, particularly in subsistence contexts; individuals too weak or ill to work are unable to secure food for themselves or their families (Pierre-Louis et al., 2007). The final component of food security is stability,

which is associated with the absence of shocks and recurring events that could impact the access, availability or utilization of food (FAO, 2006). In this context, it is insufficient to be food secure *on average* if this reflects extremes of excellent food security in one season but low food security in another season.

2.2.1 Measuring food security

Numerous methods and indices exist to measure food security. Table 1 highlights the variety of measures available. Food security measures can and have been collected at a range of scales: global, continental, regional, community, household and individual levels. Data collected for each scale range from global food supply to self-reported experiences, perceptions and behaviours of food insecurity (Ford & Berrang-Ford, 2009). For the purposes of this thesis, I have used the USDA Household Food Security Survey Module (HFSSM) (Coates et al., 2006; Melgar-Quinonez et al., 2006; Perez-Escamilla et al., 2004). The HFSSM is widely recognized and has been validated for uses across cultures, in less developed countries, emergency situations, and with Indigenous populations (Coates et al., 2006; Ford & Beaumier, 2011; Ford & Berrang-Ford, 2009; Kaiser et al., 2003; Melgar-Quinonez et al., 2006; Studdert, Frongillo, & Valois, 2001). The adaptive nature of the HFSSM and its focus on the experiences and behaviors that characterize ranges of food insecurity and hunger severity make it appropriate for vulnerable or high risk populations (Coates et al., 2006; Ford & Berrang-Ford, 2009).

Table 1: Food security assessment tools

Year	Institution	Scale	Acronym	Uses	Regions	Perceptions, Self-reporting, food quantity measurements
2009 (most recent update)	World Health Organization (WHO)	Anthropometry	N/A	Globally accepted measures for children. No consensus on adult cut-offs	All regions	Weight for height, Body Mass Index for age, Mid-Upper Arm Circumference

Year	Institution	Scale	Acronym	Uses	Regions	Perceptions, Self-reporting, food quantity measurements
2000	United States Department of Agriculture (USDA)	Household Food Security Survey Module	HFSSM	18 questions	North & South America Africa	Perceptions and behaviours
2004	Collaborative measure developed with support from Food and Agriculture Organization (FAO)	Latin American and Caribbean Household Food Security Scale	ELCSA	Variation of the HFSSM, 16 questions.	Latin & South America	Perceptions and behaviours
1960s, full implementation in 1999	Centers for Disease Control and Prevention (CDC)	National Health and Nutrition Examination Survey	NHANES	Based on HFSSM, dietary recall, Supplemental Nutrition Assistance Program questionnaire	USA	Perceptions and behaviours
2011	Famine Early Warning systems Network, Save the children, United States Agency for International Development (USAID), World Food Program (WFP), FAO, Oxfam	Integrated Food Security Phase Classification	IPC	Chronic and Acute Scales	Asia Latin & South America Sub-Saharan Africa	Uses a mix of direct and indirect data sources.
1992	Scale designed by Dr. Kathy Radimer.	Radimer/Cornell Measure of Food insecurity	N/A	12 questions in 3 interview sections; household, women and children's hunger	USA Russia Indonesia Tanzania	Perceptions and behaviours, food consumption
1996	WFP, Strengthening Emergency Needs Assessment Capacity (SENAC)	Food Consumption Score	FCS	Frequency score calculated from 9 food categories consumed in the last 7 days.	Globally	Self-reporting, food consumption
2014	FAO	Food Insecurity Experiences Scale	FIES	Based on HFSSM & ELCSA. Comprised of 8 questions	Globally, available in more than 200 languages	Perceptions and behaviours
2007	USAID funded – Food and Nutritional Assistance Project (FANTA)	Household Food insecurity Access Scale	HFIAS	Developed after HFSSM. Short 9 questions	Globally	Perceptions and behaviours
2006	USAID - funded – FANTA	Household Dietary Diversity Score	HDDS	24 hour consumption recall of 12 key foods	Globally	Dietary diversity
2011	USAID - funded – FANTA	Household Hunger Scale	HHS	3 questions based off the HFIAS	Globally	Perceptions and behaviours
2012	USAID, Strengthening Partnerships, results and Innovations in Nutrition Globally	Household Consumption and Expenditure Survey	HCES	Food consumption in the past 7-14 days	116 countries	Dietary consumption and diversity
2006	International Food Policy research Institute (IFPRI)	Global Hunger Index	GHI	3 national level indicators; proportion of undernourishment, prevalence of under-five underweight, under-five mortality rate	120 countries	Aggregation of National and International data sources.
2003	WFP	Comprehensive Food Security and Vulnerability Analysis	CFSVA	National baseline; Focus groups, anthropometrics, household interviews, Food consumption, Coping strategy index	80 countries	Perceptions and behaviours, dietary diversity, food consumption

Year	Institution	Scale	Acronym	Uses	Regions	Perceptions, Self-reporting, food quantity measurements
2012	The Economist Intelligence Unit	Global Food Security index	GFSI	28 indicators collected reflecting food insecurity.	109 countries	Aggregation of National and International data sources.

*Adapted from (Jones, Ngure, Pelto, & Young, 2013)

2.2.2 State of food security

Global food insecurity and rates of malnutrition have seen substantial improvements in the past decades, especially with the establishment of the Millennium Development Goals in 2000; globally, both the prevalence of undernutrition and underweight children have decreased by 11% (FAO, IFAD, & WFP, 2015; Schmidhuber & Tubiello, 2007; Wheeler & Von Braun, 2013). The decreases in observed food insecurity are, however, slowing as a result of stressors on access, availability and utilization of food: population growth, decreasing crop yields, economic instability, increasing in food prices, changes in dietary preferences/demands, increasing inequality, and climate change (Barrett, Charles, & Temte, 2015; FAO et al., 2015; Hinrichs, 2013; Margulis, 2013; Porter et al., 2014; Restuccia et al., 2013; Rosen et al., 2014; Wheeler & Von Braun, 2013). Geographically, these stressors are not distributed homogenously (FAO et al., 2015). Food insecurity currently affects an estimated 795M, based on aggregate data estimating the number of people with sufficient supply of 2,100 calories at a national level (FAO et al., 2013, 2015). Due to financial and feasibility constraints, other measures of food insecurity are difficult to collect at the national and global scale. Efforts by WHO, FAO, WFP and IFPRI, among others, have been made to improve data collection and estimates as it is believed the current data underestimate food insecurity (FAO et al., 2015; IFPRI, 2014; WFP, 2013; Wheeler & Von Braun, 2013).

Most food insecure populations reside in middle or low income countries (the FAO estimates that 780M of 795M live in developing regions), and food insecurity is highly correlated with poverty at global, regional, and household levels (FAO et al., 2015; Porter et al., 2014; von Grebmer et al., 2014; Wheeler & Von Braun, 2013). South Asia, for example, has the highest number of food insecure people (FAO estimates 300 million people are food insecure), and Sub-Saharan Africa has the highest proportion (FAO estimates 26.8% of population is food insecure) (FAO et al., 2013, 2015; Porter et al., 2014). Indigenous populations have been identified as at high risk for food insecurity, even in developed countries (Berrang-Ford et al., 2012; Cannon, 1995; Durkalec et al., 2015; Ford, 2012; Ford & Beaumier, 2011; Ford & Berrang-Ford, 2009; Goldhar, Ford, & Berrang-Ford, 2010; Harper, 2012; Kuhnlein & Receveur, 1996; Lewnard et al., 2014; Maldonado et al., 2014; Maldonado et al., 2014; Sherman & Ford, 2013). Indigenous populations experience higher rates of key risk factors for food insecurity, including burden of illness, poverty, inequality, low education, lack of access to services, discrimination, rural residences, reliance on subsistence livelihoods, and the effects of climate change (Berrang-Ford et al., 2012; Ford, 2012; Gracey & King, 2009; Ohenjo et al., 2006; Sherman & Ford, 2013). Additional exposures that put stress on Indigenous food systems could push populations beyond their ability to adapt, and have serious implications for health and climate change planning.

2.2.3 Food Security & climate change in Sub-Saharan Africa

Sub-Saharan Africa is highly vulnerable to the predicted impacts of climate change on its food security; extreme weather events, prolonged drought, higher temperatures and changes in precipitation patterns and intensity are expected to negatively impact yields and alter agricultural growing calendars and capacity (Apuuli et al., 2000; Challinor et al., 2007; Confalonieri et al.,

2007; Davidson et al., 2003; Gregory et al., 2005; Hussein, 2011; Jankowska et al., 2012; Kotir, 2011; Osbahr et al., 2010; Ringler, 2010; Tschakert, 2007; Walker & Schulze, 2006; Wossen & Berger, 2015). In Uganda, the majority of the population practices rain-fed agriculture and a reliable agricultural calendar is essential to maximize yields. Exposure to negative climatic events often reduces the quantity and quality of crops, and this can increase food insecurity, hunger and malnutrition (Berrang-Ford et al., 2012; Challinor et al., 2007; Hisali, Birungi, & Buyinza, 2011; Kristjanson et al., 2012; Labbé et al., 2015; Porter et al., 2014). Climate change is expected to negatively impact agriculture beyond crop yields. Livestock, forestry, aquaculture, and land quality are vulnerable to changing climatic conditions and extreme weather or disasters (FAO, 2015). Quantitatively measuring climate change is difficult, however, and there is no consensus on predictive models for impacts and adaptation planning. Seasonal variation, and its relationship with food security, has been used as a proxy to assess sensitivity and vulnerability to climate change (Antwi-Agyei et al., 2013; Costello et al., 2009; Endfield, 2007; Kotir, 2011; Osbahr et al., 2011; Osbahr et al., 2010; Porter et al., 2014; Ribot, Magalhaes, & Panagides, 1996; Wossen & Berger, 2015). Assessing a food system's current sensitivity to seasonal variability can provide a lens through which to understand how food systems respond to changing environmental conditions, and how populations respond to these changes. Though an imperfect proxy for future climate change, this has been used to provide insight into how food systems might be impacted by climatic events, and to identify opportunities for adaptation planning and enhancing resilience in vulnerable populations (IPCC, 2014; Porter et al., 2014; Wheeler & Von Braun, 2013; Wossen & Berger, 2015).

2.3 Health & climate change

The Lancet commission on Health and Climate Change's newest 2015 report states that "*tackling climate change could be the greatest global health opportunity of the 21st century*" (Watts et al., 2015). Watts et al. (2015) additionally argue that climate change could reverse the public health gains achieved during the last half of the century. Climate change is and will continue to impact health both directly and indirectly through environmental changes and stressors on socioeconomic determinants of health (Smith et al., 2014) (see figure 1).

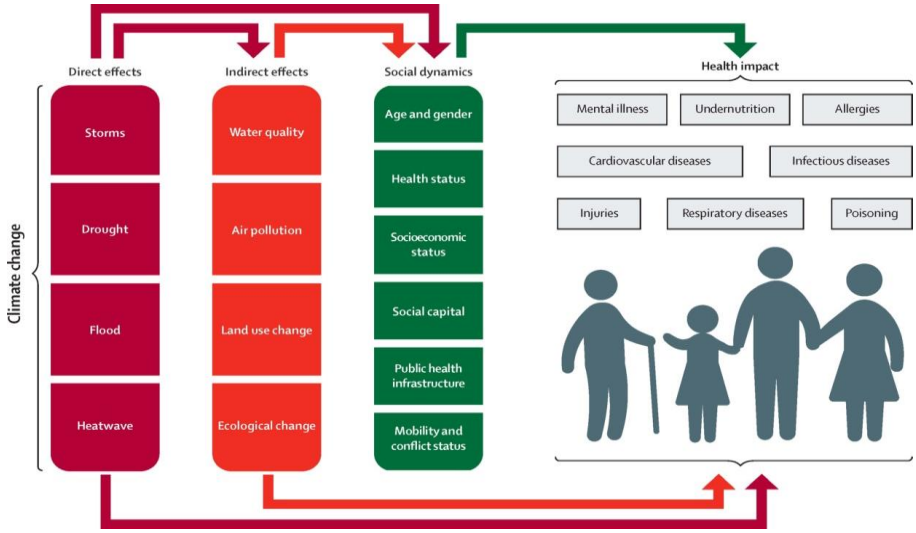

Figure 1: The direct and indirect effects of climate change on health and wellbeing (Watts et al., 2015)

The WHO estimates that climate changes cause more than 150,000 deaths annually, and conservative predictions estimate the number will increase to 250,000 per year between 2030-2050 (WHO, 2014). Climate sensitive diseases and health outcomes tend to be geographically concentrated in low income countries due to their physical environments (e.g. tropical) and poor health infrastructure leading to poor access to health care and treatment (Campbell-Lendrum et al., 2015) (See figure 2). As a result of increased temperatures, changes in precipitation and increasingly severe droughts, the prevalence and spatial distribution of infectious, water and food

borne diseases are expected to increase. For example, increases in temperature are expected to increase the spatial distribution of vector-borne diseases such as malaria and dengue beyond their current endemic regions (Campbell-Lendrum et al., 2015; Patz et al., 2014). For regions currently dealing with poor water infrastructure and shortages, further stressors may increase the likelihood of contamination and insecurity (Birendra, Schultz, & Prasad, 2011; Hanjra & Qureshi, 2010; Smith et al., 2015).

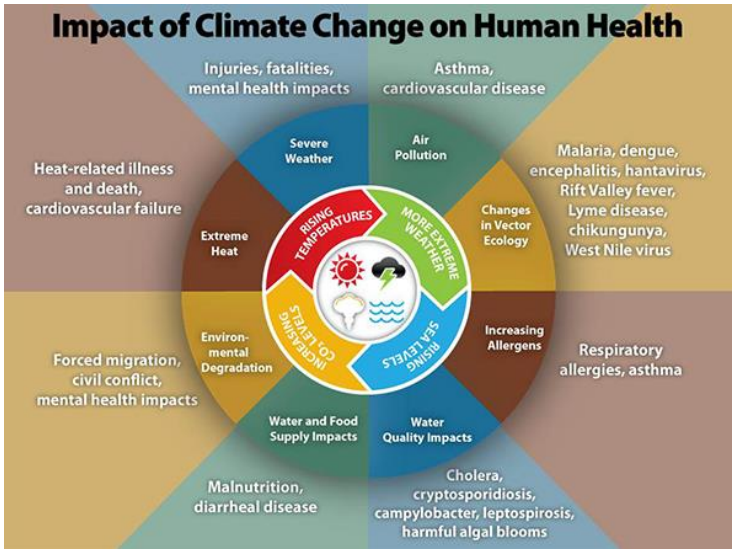

Figure 2: Impacts of climate change on human health outlined by the Center for Disease Control (CDC) (2014)

Inequalities in the social determinants of health will further exacerbate the impact of climatic events on health; poverty, lack of access to health services and age have been associated with increased heat wave-related mortality and morbidity around the world (Klinenberg, 2015; Kovats & Hajat, 2008; Lutz, Muttarak, & Striessnig, 2014). Researchers are still struggling to quantify the interactions between the health risks of climate change and social determinants of health. Understanding the current effects of climate, seasonal, or meteorological variability and social determinants on health is a valuable indicator of future sensitivity to climate change (Antwi-Agyei et al., 2013; Kotir, 2011; Labbé et al., 2015; Osbahr et al., 2011; Wossen &

Berger, 2015). Adaptation research has consistently re-iterated the pertinence of local research in climate change planning. Indigenous peoples, children, women, elderly, and the extremely poor face the highest risk of negative health impacts predicted with climate change (Barrett et al., 2015; Durkalec et al., 2015; Oppenheimer et al., 2014; Thomas et al., 2014). Improving current health and reducing poverty in vulnerable populations are essential adaptations to enhance resilience and reduce sensitivity to stressors predicted under climate change (Campbell-Lendrum et al., 2015; Haines et al., 2014; Neira et al., 2014; Watts et al., 2015; Woodward et al., 2014).

2.4 The Batwa of Uganda

The Batwa are an Indigenous Pygmy population of 70,000 living throughout Central Africa in Uganda, Burundi, DRC and Rwanda (Lewis, 2000). Approximately 6,700 reside in Uganda in the southwestern region of the country in three districts: Kanungu, Kabale and Kisoro (UOBDU, 2007). The Batwa were evicted from their ancestral forest home in 1991 during the gazetting of Bwindi Impenetrable National Park (BINP) (UOBDU et al., 2015). Historically a hunter-gatherer group, the Batwa have been forced to adapt a sedentary subsistence agricultural lifestyle (Balenger et al., 2005). Their traditionally nomadic lifestyle facilitated relocation when food sources dwindled, consequentially reducing issues of sanitation, contamination and conflict (Lewis, 2000). The Ugandan government did not, however, recognize their land claims due to their mobile lifestyle, and they were not compensated following expulsion from BINP (UOBDU et al., 2015).

The Batwa in Kanungu District live in settlements or land held in trust by Non-Governmental Organizations (NGOs) and private donors. Most Batwa households engage in subsistence agriculture and small livestock rearing, as primary sources of food. Employment opportunities for the Batwa are limited and wages are consistently lower than those of their non-

Indigenous neighbours. They work as agricultural laborers, porters, tea collectors, brick makers or making handcrafts for tourists; most employment is labour intensive. The poverty rate among the Batwa is extremely high. Access to education has been available to Batwa children through the Batwa Development Programme (BDP) since 2001. However, the adult literacy rate is less than 11%, compared to >75% among the non-Indigenous population in the Southwestern Province (UBOS & ICF, 2012).

Inequality, poverty and lack of access to education have contributed to the Batwa having some of the lowest health indicators in Uganda and they have been highlighted as one of the world's most vulnerable populations (Harper, 2012). The national life expectancy in Uganda is 59, almost double that of the Batwa's (28) (UOBDU, 2007; World Bank, 2015). Batwa health is consistently lower than their non-Indigenous neighbours; they have higher rates of child and infant mortality, malnutrition, acute gastrointestinal illness and negative maternal health outcomes (Berrang-Ford et al., 2012; Clark et al., 2014; Harper, 2012; Lewnard et al., 2014; Namara, 2007; UOBDU, 2007). No food security analysis has been conducted in this population. Pilot participatory research by Berrang-Ford et al. (2012) identified food security and malnutrition as top climate-sensitive health priorities among Batwa communities (self-identified by the communities themselves).

The precise impacts of climate change on food security for the Batwa are unknown. First, the Batwa settlements are in proximity to the forest, which creates a unique micro-climate with lower temperatures and higher rainfall than the rest of the district (Olupot, 2009). Second, there is currently a lack of monitoring and data-collection. However, whilst the specific impacts are unknown, community-based research and models predict that the area will face rising temperatures, an increase in extreme weather, and a change in precipitation (Andersson &

Gabrielsson, 2012; Berrang-Ford et al., 2012; Christensen et al., 2007; Hepworth, 2010; Magrath, 2008). Climate variation will have implications for Batwa agricultural practices, which like the rest of Uganda, are dictated by the seasonal rainy and dry seasons. Increased variability in these cycles has been noted in recent years, and decreases in crop yields have been reported. Sensitivity to these changes demonstrates the importance of understanding how the current food system is impacted by climatic, meteorological, or seasonal variation to better plan for future climatic impacts.

2.5 Conclusion

Food security is a key determinant of health. Climate change is projected to worsen food security and exacerbate climate sensitive diseases in developing countries. The Batwa of Uganda have a high burden of illness and rely on subsistence agricultural livelihoods, making them particularly vulnerable climate change impacts. Place-based research is identified in the literature as a key component of adaptation research, especially in populations that are vulnerable and have low coping capacity. By examining the scale at which food insecurity occurs (Ch. 3) and investigating how food security is impacted by seasonal variation (Ch. 4), this thesis contributes to context-specific research on Indigenous populations and the effects of climate change on food security and health.

Chapter 3: Manuscript 1

At what scales does food insecurity vary? A case study of highly food insecure Indigenous communities in SW Uganda

3.1 Role of Manuscript 1

This manuscript estimates the prevalence, identifies the determinants and examines the scale at which food insecurity varies among the Batwa of Kanungu District, Uganda. The findings presented in the literature review will be summarized to provide the context for the manuscript objectives. Examining the scale of food insecurity among the Batwa is a key component for the identification of intervention points. Often this is done by identifying the most vulnerable households within a population; this is difficult however in populations with homogenously high vulnerability. The aim for this manuscript was to determine if the household level was the most appropriate scale to measure food insecurity. A new Adapted Vulnerable Populations Score (AVPS) was developed based on the Household Food Security Survey Module (HFSSM) to capture additional variation in food security among homogenously food insecure populations. This manuscript will address the scale of food insecurity among the Batwa and demonstrate the appropriateness of the new AVPS. The findings herein can inform future study designs and work in homogenously food insecure populations and provide valuable considerations for identifying appropriate and effective intervention entry points.

3.2 Abstract

Rising food prices, constraints on agricultural land, and the occurrence of severe famines and droughts have contributed to increasing attention to global hunger and food security. One of the most common tools used to estimate food security is the USDA household food security

survey module (HFSSM) questionnaire. The HFSSM is premised on heterogeneous food insecurity among households within a population and across typical HFSSM categories. There has been little validation of the HFSSM within severely food insecure and homogenously poor populations or to test the scale-dependence. The Batwa of Kanungu District, Uganda face steep social gradients in health and high burden of disease. Our aim was to assess whether the household level is an appropriate scale of analysis to identify determinants of, and intervention points for, food security among an Indigenous African population; the Batwa of Kanungu. Our objectives were to: 1) estimate the prevalence and range of food insecurity in an Indigenous Batwa population in southwestern Uganda, 2) estimate variation in food security explained by household and community level variation, and 3) critically appraise the extent to which variation in food security is influenced by household, community, and regional determinants.

An adapted version of the HFSSM was administered 6 times at 3-month intervals between January 2013 and April 2014 (n=767 households). We apply a multilevel modeling approach to determine household and community level predictors of food insecurity, creating an Adapted Vulnerable Populations Score (AVPS) to account for variation among severely food insecure populations. The Batwa are highly food insecure (97% food insecure, 84% *severely* food insecure), ranking among the highest estimates of food insecurity published in the peer-reviewed literature. Variation in food insecurity that is explained by household and community-level risk factors was low. Our results suggest that variation in food insecurity may be poorly reflected in household-level, or even community-level analyses and that variation and key predictors of food security – and therein appropriate intervention entry points – are likely occurring at the regional scale. Food insecurity analyses should be considered scale-dependent, with increased use of multilevel modeling approaches to identify methodologically-appropriate and policy-relevant

scales of analysis. The AVPS may be appropriate for analyses where a large proportion of the population are food insecure.

3.3 Introduction

Rising food prices, constraints on agricultural land, the occurrence of severe droughts, land degradation, and population growth have contributed to increasing attention to global hunger and food security. Indeed, the eradication of extreme poverty and hunger is the first Millennium Development Goal (MDG) (Godfray et al., 2010; Hinrichs, 2013; McMichael & Schneider, 2011; Schmidhuber & Tubiello, 2007; Wheeler & Von Braun, 2013). Concerns regarding climate change impacts on food production and security have further highlighted the importance of understanding and untangling the complex combination of regional, community and household scale stressors that interact to cause food insecurity and under-nutrition burden (Apuuli et al., 2000; Challinor et al., 2007; Confalonieri et al., 2007; Davidson et al., 2003; Füssel, 2010; Parry, Rosenzweig, & Livermore, 2005; Tschakert, 2007). In sub-Saharan Africa, high dependence on agriculture makes the region especially vulnerable to biophysical, climatic, economic, and geopolitical perturbations. For marginal populations already struggling with poverty and hunger, stressors on food security may exceed their ability to adapt (Berrang-Ford et al., 2012; Lynn et al., 2013; Lynn, MacKendrick, & Donoghue, 2011).

Indigenous populations are believed to be particularly vulnerable to food insecurity due to historical patterns of neglect by governments, colonialist legacies, lack of access to resources, ethnic discrimination, low employment, extreme poverty, and dependence on subsistence livelihoods (Apuuli et al., 2000; Berrang-Ford et al., 2012; Friel et al., 2008; Füssel, 2010; Lynn et al., 2013; Lynn et al., 2011; Maldonado et al., 2014). The Batwa Pygmies, a rural Indigenous peoples living in Southwestern Uganda, are among the poorest populations within Africa. They experience a high burden of illness relative to other Ugandans — including their non-Indigenous neighbours — and face social barriers accessing health care and education (Balenger et al., 2005;

Berrang-Ford et al., 2012; Jackson, 2004; Jackson & Payne, 2003; Namara, 2007; Tumushabe & Musiime, 2006; Warrilow, 2008; Zaninka, 2001). Economically marginalized populations, subsistence-based food systems, and Indigenous peoples more generally are recognized as highly vulnerable to perturbations in the stressors of food security (Foley et al., 2011; Foley, 2010; Gregory et al., 2005; Pretty, Morison, & Hine, 2003). Despite this, there is limited place-based research on Indigenous health and food systems in general, and Indigenous peoples' food security in sub-Saharan Africa in particular (Balenger et al., 2005; Berrang-Ford et al., 2012; Jackson & Payne, 2003; Lewnard et al., 2014; UOBDU, COPACSO & FPP, 2015).

Food insecurity can be conceptualized at a range of scales, from the individual to household, or as aggregate measures for a community or nation. The household level survey is the current gold standard used most frequently to identify populations at risk (Cafiero et al., 2014; Coates, 2013; Coates et al., 2006; Coates et al., 2006; Frongillo, 1999; Jones et al., 2013), though individual level food security estimates are also common (Frongillo, 1999; Lohman et al., 2009; Weiser et al., 2009). Household level surveys characterize the variation in food security across populations to identify the most vulnerable households and frequently also to estimate determinants of food security or insecurity. This approach, however, is predicated on the assumption that households within a sampled population are heterogeneous, and that the household level reflects an appropriate scale at which to capture variation in food security. As highlighted by Pearce (2011) and Rose (2001), the most important determinants of health may vary little within a particular population, and sampling should necessarily seek to capture a scale at which health outcomes vary. While the household is undoubtedly a highly relevant unit of analysis at which many food production, access, and consumption decisions are made, a focus on household-level variation implicitly neglects empirical interrogation of higher-level population-

based determinants — at which important policy-relevant variation may occur — and intervention entry points. The use of household-level surveys for food security has herein remained relatively unchallenged as a unit of analysis, and there has been limited application of multilevel modeling within food security research (Fisher & Lewin, 2013; Hadley et al., 2011; Nalty, Sharkey, & Dean, 2013; Nawrotzki et al., 2014). What scale then is appropriate for measurement of food security, in what contexts, and how can this be determined for a particular population? To what extent does the selection of sampling unit affect the range of potential intervention options inferred from epidemiologic analysis?

We herein seek to identify and characterize variation in food security across multiple scales for a Ugandan Batwa population, guided by the question: 'Is the household level an appropriate scale of analysis to identify determinants of, and intervention points for, food security?' (Bickel et al., 2000). Objectives include: 1) estimate the prevalence and range of food insecurity in an Indigenous Batwa population in southwestern Uganda, 2) estimate variation in food security explained by household and community level attributes, and 3) critically appraise the extent to which variation in food security is influenced by household, community, and regional determinants.

3.4 Methods

3.4.1 Study population

The Batwa are an Indigenous population dispersed throughout Central Africa, and within Uganda live within three districts with a combined population of approximately 6,700. Peer reviewed and grey literature consistently cite poor health status and heightened risk among Batwa compared to their non-Indigenous counterparts (Balenger et al., 2005; Berrang-Ford et al., 2012; Jackson & Payne, 2003; Namara, 2007; Tumushabe & Musiime, 2006; Warrilow, 2008;

Zaninka, 2001). Previous research has reported that poor nutrition and low food security status are high among the Batwa (Balenger et al., 2005; Jackson, 2002; Jackson & Payne, 2003; Lewnard et al., 2014; UOBDU, COPACSO & FPP, 2015).

Previously nomadic forest hunter-gatherers, the Batwa of Uganda were evicted from their ancestral homes, with no or negligible compensation, due to the establishment of Bwindi Impenetrable National Park (BINP) in 1991 (UOBDU, 2006; UOBDU, COPACSO & FPP, 2015). This displacement forced the Batwa to adopt an agricultural and sedentary lifestyle (Balenger et al., 2005). Main food sources for the Batwa since leaving the forest include subsistence agriculture (crop cultivation & small livestock rearing) and food in exchange for manual labor (Berrang-Ford et al., 2012; Lewnard et al., 2014). In the District of Kanungu, the Batwa live in settlements and land trusts donated by NGO's and private donors. Their primary sources of employment are working in tourism, low paying manual labor or working as porters, cleaners, cooks, diggers, tea collectors, and brick makers.

Socioeconomically, the Batwa are highly impoverished compared to the Ugandan average and their non-Indigenous neighbours. Uganda's national per capital income is significantly higher (550$) compared to the Batwa (97$) (Berrang-Ford et al., 2012; Clark et al., 2014; Namara, 2007; World Bank, 2015), and adult literacy (<10%) is significantly lower than the mean for Uganda's south western province (neighbouring non-Indigenous population) (> 73%) (UBOS & ICF, 2012; World Bank, 2015). Maternal health, child mortality, infant mortality and life expectancy are all poorer among the Batwa than among neighboring peoples or the Ugandan average, and the Batwa have been highlighted as one of the world's most impoverished and marginalized populations (Clark et al., 2014; Harper, 2012; Jackson, 2006; Lewnard et al., 2014; Namara, 2007; Ohenjo et al., 2006). Despite a wealth of grey literature highlighting concerns

related to Batwa food security, there is negligible peer-reviewed research on Batwa health and food systems. Indeed, most articles in the peer-reviewed literature citing Batwa focus on the impact of the Batwa on the health of primates in Bwindi Impenetrable National Park, with limited focus on the Batwa themselves.

This research is situated in the Kanungu District of Southwestern Uganda. As of 2010, there were approximately 750[1] Batwa living in Kanungu District, scattered throughout 10 communities in 130 households (Figure 3). These communities are currently participating as partners in a longitudinal burden of illness research project, Indigenous Health Adaptation to Climate Change (IHACC, www.ihacc.ca). A series of six longitudinal open-cohort census surveys were conducted in 3 month intervals; January 2013, April 2013, July 2013, November 2013, January 2014 and April 2014 . Due to the relatively small Batwa population, each round of survey implementation aimed to capture a full census of Batwa households. 767 household and food security surveys were collected with an average of 127 households participating in each survey administration.

[1] Assessed through a pilot study in July and August 2010 in partnership with the Batwa Development Programme.

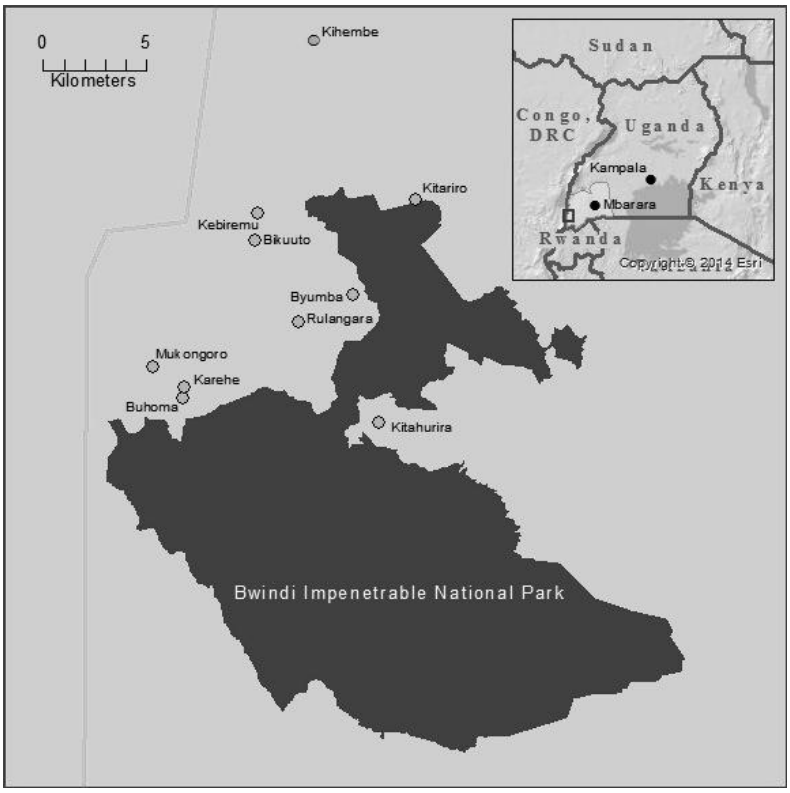

Figure 3: Map of Batwa communities in Kanungu District, Uganda

3.4.2 Ethics

Ethics approval was obtained from the McGill Research Ethics Board on research involving human subjects. All sections and questions were voluntary, with options to skip or end the survey at any time. To ensure confidentiality, all data analyzed has been de-identified and individual and household ID's have been assigned to facilitate temporal analysis. No payment was provided for participation; the communities were provided with a nutritious lunch. Participation in a questionnaire was not mandatory to receive a meal.

3.4.3 Data collection

Data were collected using three survey instruments: an individual survey, a household head survey, and a food security survey. The first was administered to all members of the Batwa community. The second was administered to those who self-identified as the household head, or

in their absence, their spouse or eldest child >18yrs. The food security survey was administered to those who self-identified as the head of household food preparation, or if they were unavailable, other suitable household members familiar with household food preparation. Questionnaires were conducted orally with participants in the local language of Rukiga, with responses recorded on a paper questionnaire. The individual and household head survey aimed to identify an individual's characteristics (health, education, employment), and a household's characteristics (size, composition, assets and wealth). The food security survey was based upon the U.S. Department of Agriculture's (USDA) household food security survey module (HFSSM), and aimed to establish the extent and occurrence of food insecurity within the Batwa community from October 2012 to April 2014. The version of the HFSSM used examined the conditions, experiences and behaviors that characterize ranges of food insecurity and hunger severity experienced over the previous 3 months (Ford & Berrang-Ford, 2009). Questions ranged from concerns about food insecurity, experiences of being food insecure and the frequency at which they occurred (Appendix I). Community level predictors were collected in consultation with partners and key informants, and were used to examine the higher level effects that impact food security, and included: crop raiding, land quality, market access and landscape type (Appendix II).

3.4.4 Food security outcome

Defining food security is difficult and as of yet there is no universally accepted definition. Food systems broadly refer to the production, processing, distribution, preparation and consumption of food (Gregory et al., 2005). Food systems can become stressed by a number of factors, including climatic (drought, flooding), economic (price or demand increases, food shortages), social (food sharing disruption), conflict (supply routes destroyed, decreased safety)

(Sherman & Ford, 2013). These lead to increased difficulty in securing food for the household or self, leading to food insecurity. The FAO defines food security as "*all people, at all times, [having] physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*" (FAO, 1996). In this sense, food *insecurity* is the limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways (Anderson, 1990). In other words, when a group is food insecure, their access to, quality of, or quantity of food resources may be lacking (Gregory et al., 2005). Food insecurity in itself is a negative outcome, but it can also indirectly lead to other negative health outcomes. Those who are food insecure typically have higher rates of under-nutrition, malnutrition, stunting, wasting, mental stress, greater risk of infection and higher rates of chronic illness (Cook et al., 2004; Hamelin, Habicht, & Beaudry, 1999; McIntyre, Tarasuk, & Jinguang Li, 2007; Vozoris & Tarasuk, 2003).

The USDA household food security survey module (HFSSM) is one of the most frequently used instruments for assessing and measuring food security, and has been validated and used internationally in less developed countries, emergency situations, and among Indigenous populations (Kaiser et al., 2003; Melgar-Quinonez et al., 2006; Studdert et al., 2001). The module categorizes food security through a scoring system, with scores then categorizes households as food secure, food insecure without hunger, food insecure with hunger (moderate) and food insecure with hunger (severe). However, the HFSSM is frequently adapted to the contexts of the population within which it is applied. The USDA HFSSM has therein been extensively adapted, using altered category ranges and cut-offs (Cook et al., 2004; Coleman-Jensen, 2010; Coleman-Jensen et al., 2011; Coleman-Jensen, Nord, & Singh, 2013; Hernandez, 2015; Jones et al., 2013; Lee et al., 2011; Melgar-Quinonez et al., 2006). For example, the

USDA HFSSM was originally designed for a national American food security survey, and several questions include baseline expectations; for example, when examining meal skipping there is an assumption that baseline participants eat 3 meals per day. In the case of the Batwa, most families eat only 1 or 2 meals per day, and thus 'number of meals skipped' reflects a more severe measure than reflected in baseline HFSSM categorizations.

To reflect the high proportion of Batwa with high food insecurity and severe hunger, we developed an Adapted Vulnerable Populations Score (AVPS) to capture variation in food security along a continuous gradient and reflecting variation at more severe levels of food insecurity (See Table 2). We used a 26 point metric to reflect a wider continuum of food security. Our HFSSM-based AVPS incorporates an additional 6 points for households without children and an additional 8 points for households with children for total maximum scores of 16 and 26 respectively (See table 3 for comparison between adapted model and USDA score/categorization). Missing data were imputed following standard USDA guidelines (Bickel et al., 2000).

Table 2: Adapted vulnerable populations score (AVPS) 26-point scale design

#	Question	Negative responses (Code=0)	Affirmative responses (Code=1)	Affirmative severe response (Code=2)	AVPS with kids	AVPS without kids
1	Worried food would run out	never	sometimes, often		1	1
2	Food bought didn't last	never	sometimes, often		2	2
3	Couldn't afford balanced meals	never	sometimes, often		3	3
4	Lesser quality foods for children	never	sometimes, often		4	
5	Couldn't feed children balanced meal	never	sometimes, often		5	
6	Children were not eating enough	never	sometimes, often		6	
Added	Number of meals	3 or 4	2		7	4
Added	Number of meals			0-1	8	5
7	Adults skipped meals	no	yes		9	6
8	Adults skipped meals number	1	1+		10	7
Added	Adults skipped meals weighted	0-2	3-4		11	8
Added	Adults skipped meals weighted			5+	12	9
9	Adults ate less than they felt they should	no	yes		13	10
10	Adults were hungry	no	yes		14	11
11	Adults lost weight because there wasn't enough food	no	yes		15	12
12	Adults did not eat for whole day	no	yes		16	13
13	Adults not eat for whole day number	1	1+		17	14
Added	Adults not eat for whole day weighted	0-2	3-4		18	15
Added	Adults not eat for whole day weighted			5+	19	16
14	Cut size of children's food	no	yes		20	
15	Children skip meals	no	yes		21	
16	Children skip meals number	1	1+		22	
Added	Children skip meals number weighted	0-2	3-4		23	
Added	Children skip meals number weighted			4+	24	
17	Children hungry	no	yes		25	
18	Children not eat for whole day	no	yes		26	

Table 3: Adapted vulnerable populations score (AVPS) 26-point scale compare to USDA HFSSM standard categorizations

USDA Categories	HFSSM	AVPS
High food security	0	0-2.32
Marginal food security	1	3-6
Low food security	2	6.96-10.44
Very low food security	3	11-26

3.4.5 Predictor variables

We selected variables that might be important for food security at the individual, household and community level based on the literature. Table 4 presents the variables that were selected for univariate testing as predictors for food insecurity, the type of variable (i.e. continuous, binary or categorical) expected direction of influence and the justification for inclusion in preliminary testing. Principle component analysis was employed to create an asset based wealth variable; the results were then transformed into quartiles to include in the model. Wealth variable selection was guided by case studies in Africa among poorer populations and field observations (Barrett et al., 2006; Filmer & Scott, 2012; Hargreaves et al., 2007; Morris et al., 2000). A large proportion of Batwa houses were constructed by the Batwa Development Programme (BDP), a local NGO, thus type, size and materials of the household were not a reflection of wealth. We controlled for seasonal variation and the sex of the participant that answered the food security survey to account for potential bias in gendered response patterns (Metallinos-Katsaras et al., 2012).

Table 4: Variables included in data analysis as potential predictors of food security among the Batwa of Kanungu District, Uganda from November 2012-April 2014

Description	Type	Expected Direction	Justification
Dependent Variable			
Food security	**Continuous/categorical (1-26). As the score rises, food insecurity increases.**		Food security exists on a continuum rather than a specific scale. A larger range enhances the ability to differentiate households those with more severe food insecurity.
Independent variables			
Household variables			
Sex of person that is the head of household	binary outcome male=1, female=0	Increase score	Households with no male head have been found to have lower food security (Garrett & Ruel, 1999; Hadley et al., 2011).
Highest level of adult female education	Categorical variable (No formal schooling (no ability to read or write) =3, Primary school incomplete (some primary school education, ability to read/write) =2, Primary complete or above (Completion of primary school and secondary, post-secondary etc.)=1	Decrease score	Higher levels of education have been predictors of food security, particularly education of mothers (Garrett & Ruel, 1999; Misselhorn, 2005; Metallinos-Katsaras et al., 2012; Uzma & Muhammad, 2004; Wamani et al., 2004)
Number of adults employed full or part time within a household	Continuous Variable	Decrease score	Employment increases wealth and access to food in kind for labour, decreasing food insecurity (Misselhorn, 2005; Osei et al., 2010; Uzma & Muhammad, 2004).
Any event of chronic illness in children or adults	Binary outcome yes=1 no=0	Increase score	Health and Chronic disease are major stressors on household wealth, resources and ability to work (Hadley et al., 2008; Hadley et al., 2011 Misselhorn, 2005; Osei et al., 2010; Seligman, Laraia, & Kushel, 2010).
Any event of adult household members partaking in alcohol	Binary outcome yes=1 no=0	Increase score	Income spent on alcohol has a highly negative impact on household food security and budget (Gulliford et al., 2003; Melchior et al., 2009).
Number of dependents under the age 18 within a household	Continuous Variable	Increase score	Households with children experience a higher food insecurity burden (Garrett & Ruel, 1999; Hadley et al., 2011; Metallinos-Katsaras et al., 2012).
Number of people within a household divided by the number of rooms.	Continuous Variable	Increase score	Variable is used as a proxy for crowding within the communities. (Garrett & Ruel, 1999; Willows et al., 2009).
Wealth	Categorical variable, 4 quartiles	Decrease score	Comprised of soap, fuel, land ownership, animal ownership, toilet type, phone, radio, remittances. (Azam & Gubert, 2006; Booysen et al., 2008; Filmer & Scott, 2012; Hadley et al., 2011; Morris et al., 2000; Osei et al., 2010; Uzma & Muhammad, 2004; Wamani et al., 2004).
Community level variables			
What type of landscape is most prevalent in the community	Categorical Variable Flat=1, Mixed=2, Hilly=3	Increase score	Flat landscape is more ideal for growing crops. Hilly or steep inclines are vulnerable to erosion (Reilly & Schimmelpfennig, 1999).
Rank the community's access to small markets or shops	Categorical variable Good=1, Fair=2, Poor=3	Increase score	Access to small markets to buy or trade goods is important for day to day access (Misselhorn, 2005; Tusiime et al., 2013).
Rank the community's	Categorical variable	Increase	Road access is key determinant to transport goods

Description	Type	Expected Direction	Justification
road access in terms of proximity and quality	Good=1, Fair=2, Poor=3	score	to trade or items bought at markets. It is also an indicator of infrastructure in the area. (Reilly & Schimmelpfennig, 1999; Rosegrant & Cline, 2003).
Rank the community's access to large trading centers or weekly markets	Categorical variable Good=1, Fair=2, Poor=3	Increase score	Larger centers and markets enable people to negotiate or barter in a competitive environment and often have lower prices than smaller centers (Misselhorn, 2005; Tusiime et al., 2013).
How often does the community have events of crop raiding	Categorical variable, often=1, sometimes=2, never=3	Increase score	Crop raiding increases the burden of food security as it reduces yields and lessens harvest (Misselhorn, 2005; Mwakatobe et al., 2014).
Rank the overall quality (fertility and yield ability) of land within the community	Categorical variable Good=1, Fair=2, Poor=3	Increase score	Arable land is a key determinant of yields and harvest potential (Foley et al., 2011; Reilly & Schimmelpfennig, 1999).
Control variables			
Sex of person in charge of household food preparation	binary outcome male=1, female=0	N/A	Control: Women are typically responsible for food preparation. (Metallinos-Katsaras et al., 2012).

3.4.6 Analysis

Food security scores for each household were calculated as described above; the distribution of the food security variable approximated normal. Univariate multilevel linear regression was used to identify candidate predictor variables collected at the individual and household levels using a threshold of $p<0.20$. Collinearity among candidate variables was assessed through the Spearman rank correlation analysis with a cut-off point of 0.7. When variables were collinear, we used R^2, confidence intervals and causal plausibility based on similar studies in Africa to select the most appropriate variable for retention. The multilevel model structure accounts for repeated measure at the household and community levels (n=170 households, n=10 communities). Three best fit models were estimated: 1) household level variables only (accounting for repeated household measures), 2) community level variables only (accounting for repeated household measures and clustering within communities), and 3) household and community level variables combined in a multilevel model (accounting for repeated household measures and community level clustering). A manual backwards stepwise

approach[2] was used in model building. Models were assessed using Akaike Information Criterion (AIC). We conducted sensitivity analyses for all excluded candidate variables by testing them in the final best-fit model. Post-estimation of the models was conducted by graphically assessing the models using Pearson's residuals and assumptions of normality and homogeneity of variance for the best linear unbiased predictors (BLUPs). Variation accounted for by the model and random affects was recorded to calculate the intraclass correlation (ICC) or variance partitioning coefficient (VPC). These were used to analyse the amount of variation accounted by each level included in the model. Finally, we assessed how well the models were able to predict true food insecurity levels of households in the sample. All analyses were conducted in Stata version 13 (StataCorp13).

3.5 Results

3.5.1 Batwa household demographics

The demographic structure of Batwa households was relatively homogenous within and across communities, with an average of 4.7 people (2.6 dependents) (Appendix III). A typical Batwa household lives in a 2-room mud house with iron sheet roofs. Sixty-five percent of households ranked in the two lowest categories of wealth. The majority of households (77%) reported owning land; the BDP and Kellerman foundation hold these land titles in trust. No households owned bicycles or motorbikes and none had electricity. Eleven percent owned phones and forty percent owned a radio. Most households did not own any animals (73%); those that did owned chickens (13%), pigs (9%) and goats (13%). Few households (10%) have external monetary support or remittances. Sixty-one percent of households had no adult females

[2] All variables were put into the model and the variable with the highest p-value was removed until a lower AIC could not be achieved. At each step the AIC of the model was evaluated to ensure the model as a whole improved when the variable in question was removed.

with formal schooling, 32% had some primary school and 7% of households had an adult female who had completed primary school.

3.5.2 Prevalence of food security among Batwa households

The Batwa Pygmies of Kanungu are severely food insecure (Table 5). According to the USDA standard categorization, 97% of households were food insecure, with 13% of households reporting low food security and 84% experiencing very low food security. The AVPS was better able to distinguish variation between households, particularly in the most severe category. The mean food insecurity score was 14.36 (out of 26) and the median was 15. Comparing these results to the USDA categorization, both the median and mean of the adapted score fall within the most severe USDA category of food insecurity. Experiences of food insecurity did not vary significantly by community.

Table 5: Food security results (using USDA HFSSM and AVPS) for Batwa households in Kanungu District, Uganda, October 2012-April 2012

Food Security level		**Households without children (%)**	**Households with children (%)**	**Total (%)**
USDA HFSSM		86	681	767
Food secure	**High food security**	7 (8)	9 (1)	16 (2)
	Marginal food security	0 (0)	10 (1)	10 (1)
Food insecure	**Low food security**	15 (17)	81 (12)	96 (13)
	Very low food security	64 (74)	581 (85.31)	645 (84)
AVPS 26-point scale				
Minimum, maximum (Standard deviation)		0-18.57 (4.70)	0-26	0-26 (5.72)
Mean		9.92	14.92	14.37
Median		10.44	16	15

Ninety percent of households responded that they were worried they would run out of food, that food wouldn't last and that they could not afford balanced meals. Households with children fed children lesser quality foods, unbalanced meals and felt they were unable to feed their children enough food. Sixty-eight percent of households reported eating two meals or fewer

per day. Seventy–one percent of adults reported skipping meals with 31% skipping more than 3 meals in the past week. The majority of adults also reported eating less than they felt they should (81%), feeling hungry (66%), losing weight (68%), and not eating for whole days in the past week (50%). Households reported cutting the size of their children's meals (89%), skipping meals (57%), children feeling hungry (59%) and children being unable to eat for a whole day (41%) in the past week.

3.5.3 Variables associated with Batwa food insecurity

Unconditional linear regression indicated that increased food insecurity was associated with lower adult female education, presence of a household member with a chronic disease, a larger total number of household members and dependents, more sleeping rooms, a higher number of people sleeping per room, and lower household wealth (Appendix IV). These univariate results accounted for repeated household measures but no other variables in the model.

At the community level, we tested the role of landscape type, road access, access to trading centres, and crop raiding. Communities ranged in size from 3 to 21 households. Landscape in communities ranged from flat to hilly, with most being mixed. No communities had *good* quality road access, fifty percent had *fair* and fifty percent had *poor* access. Access to large trading centers was fair or poor; small markets were more accessible. Land quality was generally good (40%) or poor (40%). Crop raiding occurred in communities located near the national park, 50% did not experience any crop raiding. Results of unconditional univariate analysis indicate that community factors were largely not significant in predicting food insecurity, with the exception of market access and experiences with crop raiding.

All multivariable models accounted for repeated measures of households over multiple surveys (Table 6). In the null model, intra-class correlations at the household level (0.18)

exceeded the community level (0.01), both indicating low levels of between group variation. A higher household level ICC reflects the repeated nature of the data, with households similar across multiple measurements. The household-only model retained highest level of adult female education, presence of chronic disease, number of dependents and wealth, indicating that lower female education, chronic disease within the family, a larger number of dependents, and poorer wealth status were associated with increased food insecurity. Households in the poorest quartiles (1^{st} and 2^{nd}) had significantly higher food insecurity than households in the least poor quartile (4^{th}), 1.44 ($p<0.01$, CI=0.61-2.66) and 1.66 ($p<0.01$, CI=0.55-2.77) respectively. For each dependent a household had, food insecurity increased by 0.47 points ($p<0.01$, CI=0.24-0.69). Female education was not significant but contributed to model fit. The data indicate that the presence of educated females is protective. The presence of chronic disease in a household increased the level of food insecurity by 0.87 points ($p=0.043$, CI=0.02-1.73). The ICC for the household level (0.14) decreased modestly compared to the null model.

Table 6: Final multivariate mixed effects linear regression model using random intercepts to control for repeated household measurements and community level clustering for predictors of food security among the Batwa of Kanungu District, Uganda, October 2012-April 2014

Model name (description)	Null model	Model 1 (Household predictors only)	Model 2 (Community predictors only)	Model 3 (Household and community predictors)
Intercept/Constant	14.36	10.27	14.23	10.26
Total variation (%)	32.63 (100)	30.00 (100)	32.59 (100)	29.15 (100)
Explained by household (%)	-	4.42 (14.73)	5.39 (16.53)	3.37 (11.56)
Explained by community (%)	-	-	0.48 (1.47)	0.06 (0)
Random effects/Unexplained (%)	32.63 (100)	25.58 (85.26)	26.72 (81.98)	25.72 (88.23)
Intra-class correlation/Variance partitioning coefficient				
Household level	0.18	0.15	0.16	0.12
Community level	0.01	-	0.00	0.002
Independent variables				
Highest Adult female education	-		-	
Primary complete or Above		ref		ref
Primary incomplete		0.58 (-1.16-2.33)		0.57 (-1.16-2.31)
No formal Schooling		1.35 (-0.34-3.05)		1.28 (-0.88-2.95)
Presence of chronic disease	-		-	
No		Ref		Ref
Yes		0.76 (-0.09-1.61)*		0.71 (-0.12-1.55)*
Number of dependents	-	0.48 (0.26-0.71)***	-	0.51 (0.29-0.73)***
Wealth quartiles	-		-	
Least poor		Ref		Ref
Poor		-0.81 (-2.26-0.65)		-0.72 (-2.17-0.73)
Very poor		1.62 (0.60-2.64)***		1.70 (0.69-2.72)***
Poorest		1.44 (0.33-2.56) **		1.52 (0.40-2.63)***
Crop raiding	-	-		
Never			ref	Ref
Sometimes			0.34 (-1.64-2.31)	1.06 (-0.87-3.00)
Often			0.93 (-0.32-2.18)	1.25 (0.03-2.46)**
Access to markets	-	-		
Good			Ref	ref
Fair			-1.59 (-3.24-0.06)*	-1.47 (-3.06-0.11)*
Poor			-0.17 (-2.06-1.71)	-0.49 (-2.31-1.33)
AIC of model	4816.425	4780.39	4815.815	4777.72

CI, confidence interval
Coefficients and P-values generated from best fit models
*0.10 ** 0.05 ***0.01
*This model controls for seasonal variation

The final community level model retained crop raiding and access to markets, with communities subject to regular crop raiding showing higher levels of food insecurity (0.99 point

increase compared to those with no crop raiding). Access to markets was associated with higher food insecurity. Households in communities with fair access to markets had a food insecurity score 1.81 points (p=0.015, CI= -3.28 to -0.35) *lower* (i.e. more food secure) compared to households in communities with good access. The explanatory power of the community level model was poorer (higher AIC) compared to both the null and household level models. Further, community level clustering accounted for less than 1% of the variation, with variation from random effects >99%. These results indicate that food insecurity is highly homogenous among communities, and that community differences do not contribute to explaining variation among households in food insecurity.

The final best fit multilevel model incorporating both household and community level variables and accounting for repeated household measures and community level clustering retained four household level and two community level predictors (identical to those retained by the household-only and community-only models). Coefficients of the variables varied only marginally between the models; both direction and strength of associations for all variables were stable across the 3 models. Wealth – measured via PCA – had the largest protective impact on the food security score, though even in the case of wealth, the magnitude of impact was relatively low: a difference of only 1.7-2.3 points on a scale of 26 for food insecurity between the poorest and least poor quartiles. Community level variation, similar to the Model 2 was <1%, while variation explained by the household level decreased to 11%. Post-estimation diagnostics were normal and the model was a good fit for the data.

Despite the retention of significant independent variables at both the household and community levels in the best fits models, all models had poor capacity to explain variation in food security among households and communities. Notably, all regression coefficients were

relatively low, even for categorical independent variables with high theoretical predictive capacity (e.g. education, wealth).

3.6 Discussion

Our findings represent among the highest levels of food insecurity recorded in the peer-reviewed literature. Ninety seven percent of Batwa households in Kanungu were found to be food insecure. Further, to our knowledge there are no studies that report higher severe food insecurity than the Batwa (84%). Levels of food insecurity among Batwa exceed reported prevalence among the Ugandan population in general, confirming findings of high impoverishment and anecdotal and grey literature reports of severe food insecurity (Balenger et al., 2005; Berrang-Ford et al., 2012; Jackson, 2003; UOBDU, 2010). Reduction in food intake was prevalent at higher rates for adults than children. This is consistent with similar findings found elsewhere, and supports the theory that households may be protecting children from hunger: adults take on a higher burden and buffer children's exposure to food insecurity (Hadley et al., 2008; Leonard, 1991; McIntyre et al., 2003; Oldewage-Theron, Dicks, & Napier, 2006).

We considered both community and household level food security variables to explain variation in food insecurity among the Batwa. Community variables, though retained in the best fit model, provided negligible power to explain variations in food security. Several household level variables provided weak but significant explanatory power. The number of dependents increased household experiences of food insecurity. This finding is similar to other case studies of highly food insecure populations (Altman, Hart, & Jacobs, 2009; Amaza et al., 2012; Bogale, 2012; Bogale & Shimelis, 2009; Feleke, Kilmer, & Gladwin, 2005; Maharjan & Joshi, 2011). Larger households have more numbers to feed, and the Batwa lack sufficient wealth and assets to ensure adequate food for each member. Children present a particular burden as they are unable to

contribute to household wealth or food acquisition. Adults within communities work for food in-kind or for money, which is then shared with household members unable to work (including dependents or elderly). Additionally, education and health costs of dependents increased the burden on household wealth (Amaza et al., 2006; Bogale, 2012; Bogale & Shimelis, 2009; Janssen et al., 2006; Wahlqvist et al., 2012). The presence of chronic disease within households negatively impacted food security among the Batwa. Chronic disease in adults reduces income earning potential and among both adults and children it is a financial burden (UBOS & ICF, 2012). Adult female education was predictive of food security. Among the Batwa, adult literacy is very low compared to the Ugandan average and women tend to be less educated. Formal educational opportunities — within the Ugandan national schooling system —were largely absent for Batwa until their eviction from the forest in 1991, and many were unable to afford the school fees until the Batwa Development Programme established a scholarship program for all Batwa children to attend school for free in 2006. Older Batwa (>45 yrs) typically have no formal education, while education of younger adult Batwa remains limited. Young Batwa (<20 yrs) have the highest levels of education (increasingly frequent attendance at secondary school and a small number of post-secondary students) and reflect an emerging generational shift in education levels of future adults and household heads.

In lower income countries, the wealth acquisition of rural populations is typically from agriculture or manual labour and/or remittances. Wealth assets usually center around owning animals, radios, cell phones and modes of transportation (Antwi-Agyei et al., 2013; Chenyambuga, Nalaila, & Mbaga, 2008; Demeke, Keil, & Zeller, 2011; Devendra & Chantalakhana, 2002; Échevin, 2013; Filmer & Pritchett, 2001). National predictors of food insecurity in Uganda include poverty, living in rural areas compared to urban, having a female

headed household, subsistence farming, owning land and distance to access the land (UBOS & ICF, 2012). Eighty percent of Uganda's population depends on agriculture. Among the Batwa, however, owning land was not found to be significant in affecting food security, likely since most land has been purchased through an NGO and is held in trust; indeed, Batwa report poor land fertility and low yields (Beyene, 2014; Holden & Shiferaw, 2004). This is further exacerbated by experiences with crop raiding by wildlife; communities within close proximity of the BNIP borders report higher frequency of raiding events (Hartter, 2009; Hill, 2000; Mwakatobe et al., 2014). Owning animals, having employed members of the household and remittances were all theorized as indicators of wealth within the Batwa population and as predictors of increased food security. Owning animals was not significantly associated with increased food security, likely due to low ownership within these communities. Household employment was analysed through number of members working, number working full time jobs, number of women employed, and presence of a salaried job. None of these were significantly associated with food security. Remittances were not predictive of food security; rather than being a reflection of wealth, it may demonstrate need for outside financial aid (Mabogunje, 2007).

Lack of variance in both food security outcomes and measured predictors constrained analysis and identification of the determinants of food insecurity among the Batwa. Exposure to adverse realities does not vary among the Batwa: all Batwa report difficulty accessing sufficient food. Few have animals, assets, employment or financial resources to ensure a consistent food source. Interpretation of significant determinants based on these results would point to interventions targeted at educating women, eliminating chronic disease presence, reducing family size and increasing wealth. While such interventions are likely to be appropriate within this population, their implementation and effect can be expected to necessitate community or

region-wide intervention, and household level models in this case provide little contribution towards a targeted evidence base for intervention and policy development.

Social networks and sharing networks may explain some of the absence of variation in food security outcomes, and the low impact of wealth (Perkins, Subramanian, & Christakis, 2015). Data on social networks were not available for this research. Social and reciprocal relationships are often found in Indigenous groups globally and may help explain how households are able to acquire food if not through typical sources of wealth i.e. owning animals or having a wage employment (Egeru, 2012; Ford & Beaumier, 2011; Mertz et al., 2010; Osbahr et al., 2011; Osbahr et al., 2010). However, homogenously extreme impoverishment, as in this case, may preclude development of effective social and reciprocal networks. Rose (2001) highlights the shortcomings of seeking within a homogenous population to identify outliers and defining normal as the average within a local population: as a result, "real" determinants — those outside the scale of study —may remain undiscovered. Rose further argues that policy-relevant variance may be observable only between populations rather than within them, particularly if an exposure is unvarying at the scale of analysis.

The scale at which food security should be measured is debated in the literature with no clear agreement (Deitchler et al., 2010; Haddad & Kanbur, 1990; Quisumbing, 2013). Policy makers and governments favour the household level measure as it is cost effective yet focused enough to deal with context specific issues. Some argue that the current household scale of food security analysis is overly broad and suggest that the individual level would be more appropriate (Deitchler et al., 2010; Quisumbing, 2013). However, there has been negligible empirical research attempting to integrate broader scale determinants of food insecurity into quantitative food security research, despite advances in multilevel modeling. Misselhorn's (2005) review of

the drivers of food insecurity in southern Africa re-iterates the role of external factors on household predictors of food security. Misselhorn found that food insecurity resulted from "the interaction between environmental stressors, and socio-economic conditions over various time scales" (2005, 37). Developments in public health research highlight growing recognition of "neighbourhood" (or higher level) effects, and multilevel modeling techniques are increasing applied to understand the relative contribution of determinants of health outcomes across scales (Cummins et al., 2007; Diez Roux & Mair, 2010; Kumanyika & Grier, 2006; Leventhal & Brooks-Gunn, 2000; Pickett & Pearl, 2001; Sampson, Morenoff, & Gannon-Rowley, 2002).

Notably, the selected scale of analysis plays a role in predetermining the range of interventions identified: even predictor variables that cause 100% of poor outcomes will explain 0% of variation in that outcome if that variable is invariant in a population (Pearce, 2011). In the case of food insecurity among the Batwa, our results imply that the most significant determinants of food insecurity may explain little of the variation in food insecurity not because they are not important causes of food insecurity, but because they vary little when households are used as the scale of analysis. The Batwa face larger social mediating effects that are invariant at the household scale or even community scale, including exposure to inequality, lack of social capital and access. In this case-study, even multilevel modeling to include the community level is insufficient. Herein, multilevel models that include regional comparisons (Batwa versus neighbouring populations) would be required to fully — and appropriately — identify the distinctive causes of Batwa food insecurity.

Chapter 4: Manuscript 2

Seasonal variation of food security among the Batwa of Kanungu, Uganda

Role of manuscript 2

This manuscript addresses objective four of this thesis: Quantify, critically assess and characterize seasonal variation in Batwa food systems. Herein, we quantitatively and qualitatively assess the lived experience of food insecurity and seasonal variation among the Batwa. A brief summary of the previous manuscript and the literature review are included to provide adequate background and context for publication. Due to the recent identification of climate change as an opportunity to improve global health through adaptation, we herein seek to establish the sensitivity of food security to seasonal variation (an imperfect proxy of climate change). We further sought to examine whether social factors play a role in mediating seasonal impacts on food security. The findings demonstrate that even in homogenously food insecure populations seasonal variations can increase severity and indicate future sensitivity to increased seasonal variations. This manuscript supports findings that socioeconomic indicators can mediate the impact of seasonal variation on health outcomes.

4.2 Abstract

Climate change is projected to increase the burden of food insecurity globally, particularly among populations that depend on subsistence agriculture. The impacts of climate change will have disproportionate effects on populations with higher existing vulnerability. Indigenous peoples consistently experience higher levels of food insecurity than their non-Indigenous counterparts, and are more likely to be dependent upon land-based resources. This study aimed to understand the sensitivity of the food system of an Indigenous African population, the Batwa

of Kanungu District, Uganda to seasonal variation. A concurrent, mixed methods (quantitative and qualitative) design was used. Six cross-sectional retrospective surveys provided quantitative data to examine the seasonal variation of self-reported household food insecurity within 10 communities. This was complemented by qualitative data from focus group discussions with community members (n=14), as well as semi-structured interviews (n=15) with local key informants, health workers and governmental representatives. The dry season was significantly associated with increased food insecurity in the quantitative surveys and identified in the qualitative interviews. Most families experienced more difficulty in acquiring sufficient quantities of food and reported eating lower quality foods during the dry season. However, the qualitative data indicated that the effect of seasonal variation on food security was modified by employment, wealth and community location. These findings highlight the role social factors play in mediating seasonal impacts on food security, and support calls to treat climate associations with health outcomes as non-stationary and mediated by social sensitivity.

4.3 Introduction

Populations already experiencing high food insecurity, particularly those engaged in subsistence agriculture, have been highlighted as among the most vulnerable to the health impacts of climate change (Durkalec et al., 2015; Franchini & Mannucci, 2015; Smith et al., 2015; Watts et al., 2015; Woodward et al., 2014). Sub-Saharan Africa is expected to be particularly affected by climatic events such as extreme drought, increased temperatures and unpredictable precipitation (Barrett et al., 2015; Haines et al., 2014; Smith et al., 2014; Thomas et al., 2014; Woodward et al., 2014). Climate change impacts will manifest differently across regions at both broad (continental) and local (household) scales, as they will be mediated by existing socio-economic variation within populations (Aase, Chaudhary, & Vetaas, 2010; Morton, 2007). Key drivers of food insecurity include social gradients (poverty, inequality, barriers to access), economic conditions (price or demand increases, food shortages), and conflict (supply routes destroyed, decreased safety) (Eriksen, Brown, & Kelly, 2005; Eriksen et al., 2009; Ford & Beaumier, 2011; Goldhar et al., 2010; Stamoulis & Zezza, 2003). At the national and regional scales climate change can impact the food system directly (crop failure due to increased temperatures and droughts) or manifest through indirect or secondary avenues (conflict as a result of food or water scarcity), that can lead to food insecurity (Jessup et al., 2013; Oppenheimer et al., 2014; Patz et al., 2014; Porter et al., 2014). At the household and individual levels, poverty and poor health currently restrict access to adequate food. Particularly in subsistence agricultural settings where food is acquired through manual labour, poor health can limit the ability to work for food, increasing malnutrition, which can lead to additional exacerbation of poor health and thus creates a negative feedback cycle.

Food insecurity arises when there is sufficient stress on food systems such that household's access to, and quality or quantity of, food resources are impeded (Gregory et al., 2005). Food insecurity in itself is a negative outcome, and it can also lead indirectly to other negative health outcomes. Those who are food insecure often have higher rates of under-nutrition, malnutrition, stunting, wasting, mental stress, greater risk of infection and higher rates of chronic illness (Jones et al., 2014; McIntyre et al., 2007; MAL-ED, 2014; Prendergast & Humphrey, 2014). Decreases in food security can thus lead to further deterioration of health among vulnerable populations through indirect effects and positive feedback mechanisms (Sheffield & Landrigan, 2011). To this end, the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) states with high confidence that "the interaction of climate change with food security can exacerbate malnutrition, increasing vulnerability of individuals to a range of diseases" (Oppenheimer et al., 2014).

Sub-Saharan Africa has been identified as one of the most vulnerable regions in the world to the impacts of climate change on food security (Apuuli et al., 2000; Confalonieri et al., 2007; Davidson et al., 2003; Füssel, 2010; Tschakert, 2007; Thompson, Berrang-Ford, & Ford, 2010). In Uganda, adverse effects of climate change are already being observed, namely decreased food security and malnutrition (Apuuli et al., 2000; Berrang-Ford et al., 2012; Hartter, 2009; Hepworth, 2010; Hussein, 2011; Labbé et al., 2015; Magrath, 2008; Mukuve & Fenner, 2015; Okonya, Syndikus, & Kroschel, 2013). Some of the highest rates of food insecurity globally in the published literature have been recorded among the Batwa of Kanungu District, Uganda, a highly impoverished Indigenous population where 97% of households were found to be severely food insecure (Patterson et al., Prep). These results are supported by literature highlighting the high vulnerability and sensitivity of Batwa health and consistently poorer health outcomes

compared to their non-Indigenous neighbours (Berrang-Ford et al., 2012; Clark et al., 2014; Labbé et al., 2015; Lewnard et al., 2014).

There is negligible placed-based research on the extent to which climate change will affect food insecurity among vulnerable Indigenous populations in Africa (Berrang-Ford et al., 2012; Walker & Schulze, 2006;). Projections of future impacts on food insecurity and planning for pathways to adaptation are predicated on an understanding of how current food systems are affected by environmental change and seasonal variation. This includes estimates of seasonal effect, but also an understanding of the causal mechanisms by which the impacts of seasonal signals manifest through – and are mediated by – social determinants of health. We contribute to this research gap by critically assessing and characterizing seasonal variation in Batwa food systems. Objectives include: 1) assess the impact of seasonal signals on food security, 2) characterize the lived experience and perceptions of the seasonal variation of food security, and 3) analyse potential associations mediating factors between season and food.

4.4 Methods

4.4.1 Study location and population

This research is situated in the District of Kanungu in Southwestern Uganda (Figure 4). As of 2013, there were approximately 750 Batwa living in 10 settlements in Kanungu District. These communities are currently participating as partners in an ongoing research project, Indigenous Health Adaptation to Climate Change (IHACC, www.ihacc.ca), with parallel sites in the Peruvian Amazon (Shawi, Shipibo) and the Canadian Arctic (Inuit).

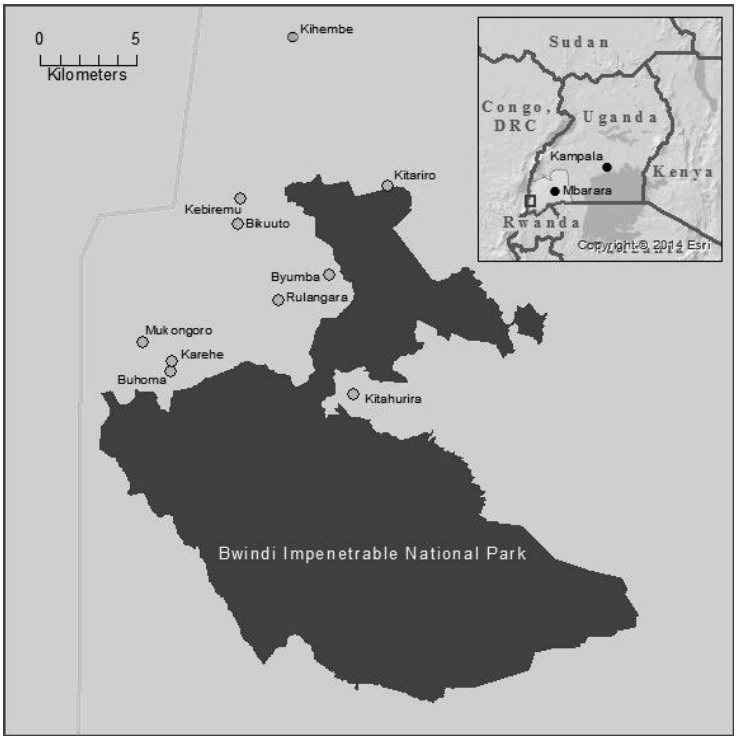

Figure 4: Map of Batwa communities in Kanungu District, Uganda

The Batwa are an Indigenous Pygmy population that reside throughout central Africa. In Uganda, they live in 3 districts in the southwest of the country, and were historically forest dwellers in what is now Bwindi Impenetrable National Park (BINP). Traditionally the Batwa were hunter-gatherers; their nomadic lifestyle facilitated relocation when food sources dwindled, and reduced issues of sanitation, resource depletion, and conflict (Lewis, 2000). Following the establishment of BINP in 1991, the Batwa were displaced from their forest homes and transitioned into fixed settlements dependent upon agriculture (Balenger et al., 2005; Bitariho et al., 2006). Most Batwa were not compensated for this expulsion, lacked any historic experience or expertise in agriculture, and had limited exposure to a cash economy (Zaninka, 2001). The bulk of the displaced Batwa population currently lives in settlements or land trusts donated and supported by non-governmental organizations (NGO) and private donors, particularly the Batwa

Development Programme (BDP). The BDP provides housing materials (metal sheets used for roofing) and sponsors Batwa children to attend local schools (BCH, 2014). Subsistence agriculture − crop cultivation and small livestock rearing − comprises the main source of food for the Batwa. This is complemented by trade with other farms, food bartered in exchange for manual labour, or cash earned from employment used to purchase food at the market. Some Batwa now engage in low paying manual labor, working as porters, cleaners, cooks, diggers, tea collectors, brick makers, cultural dancers or selling handcrafts to tourists. The annual mean income per capita for Batwa is estimated to be 160$ USD (0.44$ a day)[3], considerably lower than the Ugandan national per capita income of 600$ USD (1.64$ per day) (Namara, 2007; World Bank, 2015). Substantial inequities in access to education are evident in literacy rates: the Batwa living in Kanungu District had an adult literacy rate <12%[4] compared to >75% among the neighbouring non-Indigenous populations in the Southwestern Province (Berrang-Ford et al., 2012; UBOS & ICF, 2012). These factors, combined with persistent ethnic discrimination and relatively unsuccessful adjustment to agricultural livelihoods and the cash economy, have contributed to the Batwa having some of the lowest health indicators in the country; they have been highlighted as one of the world's most vulnerable populations (Harper, 2012). Maternal health, child mortality, infant mortality and life expectancy are all poorer among the Batwa than in neighboring populations and/or the Ugandan average (Harper, 2012; Jackson, 2004; Namara, 2007).

High mean prevalence and severity of food insecurity among the Batwa of Kanungu District have already been reported and are in preparation for publication, with 97% of

[3] Namara (2007) is the most recent estimate of Batwa income (97$ annual per capita income or 0.26$ a day). Although worse off than the Ugandan population, Batwa wages and opportunities for employment have improved since 2007. The estimate we have included here is calculated using a ratio of the 2007 Ugandan per capita income (362$) compared to Namara's estimate of the Batwa per capita income. We have adjusted this ratio to reflect the current national average per capita annual income of 600$ according to the World Bank (2015).

[4] The most recent data for adult literacy rates was collected in 2007 by the UOBDU. They found 75 adults out of 646 (11.6%) in Kanungu district were able to read or write. This has likely increased in the last decade, but the rates are still far lower than the Kanungu District adult literacy rate (UOBDU, 2007).

households found to be food insecure, and 84% having *very low* food security[5] (Patterson et al., Prep). The level of food insecurity found among the Batwa is substantially higher than the national Ugandan average of 20.3% (UBOS & WFP, 2013), and the highest published in the peer-review literature. Batwa agricultural practices, like much of Uganda, are associated with the seasonal wet and dry months that dictate planting and harvesting. Predictions of climate change in Uganda include increased and unpredictable rainfall, rising temperatures, and more frequent extreme-weather events (Berman, Quinn, & Paavola, 2015; Christensen et al., 2007; Egeru, 2012; Hepworth, 2010; Magrath, 2008; Mukuve & Fenner, 2015; Okonya et al., 2013) . Little is known about how climate change will manifest locally due to a lack of meteorological and social monitoring and data collection; however, regional models and community-based research indicate that Kanungu will face rising temperatures, an increase in extreme weather and a change in precipitation (Andersson & Gabrielsson, 2012; Berrang-Ford et al., 2012; Christensen et al., 2007; Hepworth, 2010; Magrath, 2008).

4.4.2 Research approach

A mixed methods approach was employed to understand the impact of seasonal signals on Batwa food systems in Kanungu District (Bradshaw et al., 2001; Bryman, 2006; Charron, 2012; Sale et al., 2002; Sandelowski, 2000). Assessing vulnerability is a core component of establishing the impact of climate change on human health. Broadly, vulnerability is the exposure of a system to a harmful stimulus or stimuli; in climate research it encompasses the exposure, sensitivity and adaptive capacity of a group to climatic events (Ford & Smit, 2004; Ford et al., 2010; Turner et al., 2003; IPCC 2007). Non-climatic determinants of health and food security are vital in analysing a population's sensitivity. Populations that are poor or that have

[5] Most severe food insecure category using the USDA household food security survey module.

high health burdens are very sensitive to external stressors like climatic impacts and tend to have lower adaptive capacity. Socio-economics, social networks, infrastructure, environment, traditional knowledge, political context, and access to resources all contribute to a population's sensitivity and adaptive capacity to climate exposures (Adger & Kelly, 1999; Ford & Smit, 2004). Assessing the determinants of a population's sensitivity provides a manner in which to address vulnerability and enhance adaptive capacity, to not only reduce the negative impacts of climate change, but also to reduce the impact of other non-climatic stressors (Ford & Smit, 2004). Climate or seasonal variation is responsible for the majority of the yearly changes in agricultural yields. The ability to cope with seasonal variation is imperative and often involves planning, risk mitigation, and livelihood diversification, particularly for subsistence populations. Sensitivity to these seasonal signals, though imperfect proxies for long-term climate change, provide a lens through which researchers can characterize how food systems are affected by changing environmental conditions currently (IPCC, 2012, 2014; Woodward et al., 2014). A longitudinal study design was used to provide multiple measures from each season. Shorter-term studies can be skewed by conditions during the study period and may not demonstrate the norm or longer-term trends, particularly for food security and malnutrition (Kemper et al., 1996; Sheffield & Landrigan, 2011).

4.4.3 Quantitative data collection and analysis

To quantitatively investigate potential seasonal signals and their impact on food security, six retrospective cross-sectional surveys from all 10 Batwa communities in Kanungu District (n=767) were analysed. Three surveys occurred in the dry season (January 2013, July 2013 & January 2014) and three during the rainy season (April 2013, November 2013 & April 2014). Due to the small size of the Batwa population, an open-cohort attempted-census of all Batwa

households in the district was conducted. The household response rate varied between 95-99% over the six survey administrations. Three survey instruments were used to collect: 1) individual characteristics and risk factors, 2) household characteristics and risk factors, and 3) household food security status (Appendix I). The individual survey was administered to all members of the Batwa community. The household survey was administered to those who self-identified as the household head, or in their absence, their spouse or eldest child >18yrs. The food security survey was administered to those who self-identified as the head of household food preparation; if they were unavailable, other suitable household members familiar with household food preparation were selected. Surveys were conducted orally in Rukiga, the local language, with responses recorded on a paper questionnaire. Community level predictors were collected in consultation with partners and key informants, and were used to examine the community level effects that impact food security, and included: crop raiding, land quality, market access and landscape type (Appendix II).

4.4.3.1 Dependent variable

The household food security survey module (HFSSM) developed by the United States Department of Agriculture (USDA) was adapted for the application with the Batwa; the questionnaire addressed perceptions and severity of household food insecurity (Appendix II). The module was comprised of 10 questions (18 in the case of households with children) covering the previous 3 months, that addressed conditions, experiences and behaviours associated with food insufficiency (Bickel, 2000; Ford & Berrang-Ford 2010). The subsequent scores were then placed within 4 categories: high food security, marginal food security, low food security and very low food security. Patterson et al. (Prep), described a lack of variation using the USDA categories, with most Batwa categorized as having very low food security; they employed an

alternative 26 point scale (the *Adapted Vulnerable Populations Score, AVPS*). The *AVPS* incorporates an additional 6 points for households without children and an additional 8 points for households with children for total maximum scores of 16 and 26 respectively. Therefore, we used both the USDA score (to allow comparison to international research employing the USDA scoring system) and Patterson et al.'s (Prep) AVPS (to capture greater variation in food insecurity for this population) in our analyses of seasonal variation.

4.4.3.2 Analysis

Descriptive statistics were used to examine the severity of food insecurity and longitudinal patterns. To assess the seasonal variation of food security, we constructed a multilevel model using a continuous variable for food security based on the AVPS (26 point scale), and accounting for significant household and community level predictors of food security (Bickel et al., 2000; Gebreyesus et al., 2015). Identification of key variables was guided by results in Patterson et al. (Prep), and included: wealth, female education, presence of chronic disease, number of dependents, crop raiding and access to markets. The model was structured using random intercepts to account for (1) repeated measure of households across seasons, and (2) clustering at the community level (n=170 households, n=10 communities). To investigate the seasonal variation of specific components of food security among the Batwa, univariate logistic regression models examined the relationship between seasonal variation and each of the 10 (18 for households with children) questions in the HFSSM. Other variables related to food security such as employment were assessed for seasonal variation using univariable testing. All analyses were conducted in Stata version 13 (StataCorp13).

4.4.4 Qualitative data collection and analysis

Fourteen semi-structured focus group discussions (FGDs) were conducted from June to August 2014 (dry season). A discussion guide was developed based on field observations, review of the literature and applications in similar settings. The guide was reviewed by local researcher partners and key informants, and then piloted in one community (Appendix V). Wording was specifically chosen to ensure comprehension in Rukiga (the language of the FGD participants), and to ensure cultural appropriateness. The guide consisted of three open ended questions; 1) "*Tell me about how you get food and what you eat?*", 2) "*What do you think food security is?",* and 3) "*Is there more food at some times of the year than others?*". The guide also included follow-up and/or additional prompts as needed. Specifically, the FGDs focused on the personal experiences of food insecurity and perceptions of seasonal variation. Each community chairperson was approached before the interviewing day to seek permission to interview community members and discuss the research questions and purpose. On the interview day, participants were purposively invited to reflect a range of food (in)security levels based on their responses to the household food security survey . However, any additional participants were welcomed to participate if they self-selected to join. Group sizes ranged between 3 and 10 individuals, depending on community size. Communities were also purposefully selected to represent the range of experiences within Kanungu District; key factors included location, composition and population size. FGDs ranged between 31-66 minutes and lasted an average of 45 minutes, for a total of 637 interview minutes.

Key informants (KI) from health, government, NGOs, religious and community sectors were interviewed (n=15). They were recruited based upon their expertise with the research subject, and their capacity to comment on Batwa health and food systems. Semi-structured

interviews (SSI) provided a framework for the interview, but were flexible enough to accommodate the variation in expertise, allowing for elaboration or omission of questions (Berg, 2004; Bradshaw, 2001; Wengraf, 2001). The SSI interview guide covered Batwa health and food systems, food security, seasonal variation and the possible implications of climate change (Appendix VI). The SSIs ranged between 17-38 minutes lasting an average of 25 minutes, for a total of 329 interviewing minutes. All SSI participants were asked to choose their preferred language for the interview, English or Rukiga; all key informants chose to be interviewed in English.

The positionality of the researcher and research team was acknowledged reflexively throughout the research as it can actively change the data collected and the way it is subsequently interpreted (Kitchin & Tate, 2000; Longhurst, 2009; Rose, 1997; Valentine, 2005). Asymmetrical relationships can develop in interviewer-interviewee relationships, particularly when working with Indigenous or vulnerable populations (Winchester, 1996). We sought to negotiate and manage this power imbalance by making every effort to create a safe and comfortable space for participants (Baxter & Eyles, 1997; Kitchin & Tate, 2000). FGDs were used within all the Indigenous communities to minimize imbalances in power; these were further divided by gender to allow for a dynamic where Indigenous women and men were the majority and in control of the conversations (Bradshaw, 2001; Kitchin & Tate, 2000; Longhurst, 2009 Valentine, 1999, 2005). The FGDs were conducted in Rukiga within the communities, usually at a communal gathering place. FGDs were facilitated by one of the authors (FT) who is Ugandan and proficient in both Rukiga (local language) and English. A second research assistant translated the group discussion to KP in real time to ensure data collection quality.

Memoing, as outlined by Birks, Chapman & Francis (2008) was employed throughout the FGDs by KP. Memoing highlights main themes, colloquialisms, tone and any additional observations a researcher deems important (Birks et al., 2008; Dicicco-Bloom & Crabtree, 2006; Flowerdew & Martin, 2005). We also utilized member checking; Baxter & Eyles (1997) explain that this enables researchers to ensure transcripts reflect participants' thoughts and ideas accurately and appropriately. All SSIs and FGDs were audio recorded. The FGDs conducted in Rukiga were orally translated by FT and transcribed by KP. As is common practice, all interviews were transcribed the day after their administration (Gill et al. 2008; Valentine, 2005;). A research assistant who was present for all FGDs validated the translations. Coding and memoing were used to analyze the interview data; these approaches have been validated as appropriate and methodologically rigorous to extract meaning from text (Crang, 2005; Flowerdew & Martin, 2005; Miles, Huberman, & Saldaña, 2013). Both *a priori* (from the literature, research objectives and observations and experiences in Kanungu) and *a posteriori* (using themes and categories that emerged from the interviews themselves) coding were used to classify and categorize data from the FGDs and SSIs (Dicicco-Bloom & Crabtree, 2006; Flowerdew & Martin, 2005; Madge & Bee, 1999). Two coding cycles were conducted. The first took place in Kanungu using Microsoft Word and primarily focused on findings from the interviews themselves. Several of the authors worked to code data together during the first cycle (Miles et al., 2013). The second coding cycle was conducted through Atlas.ti (Version 6.2), and built upon the work and familiarity of the data from the first cycle. Codes developed in cycle one were re-assessed and validated with the literature before beginning the second coding cycle. An exhaustive set of codes was created until all interview data were classified (Dicicco-Bloom & Crabtree, 2006; Flowerdew & Martin, 2005; Miles et al., 2013; Wolcott, 1994). The coding

supported the analysis of the qualitative data to identify causal mechanisms linking seasonal variation and food insecurity.

4.4.5 Research ethics and informed consent

Ethics approval was obtained for both the quantitative and qualitative components from McGill University on research involving human subjects. Informed consent was obtained for participation in the survey, focus group discussions and interviews and all components were voluntary, with options to skip or stop at any time. All survey data were de-identified, key informants were asked if they would like to be acknowledged via a pseudonym or by their name, and FGD data were aggregated to avoid identification post-interview. The communities were provided with a nutritious lunch, and participation was not mandatory to receive a meal. Key informants were given small tokens of gratitude (key chain), but no monetary compensation was provided. This research was guided by a community-based participatory research (CBPR) approach, and all communities have been engaged as research partners since the project planning stages.

4.5 Results

4.5.1 The Batwa are chronically food insecure

The prevalence and severity of 'very low food security' was consistently high across all surveys (Table 7). The proportion of households with a USDA HFSSM designation of very low food security ranged from 79-92%, consistently within the category 'low food security'. Similarly, the mean Adapted Vulnerable Populations Score (AVPS) ranged from 13.6-15.8, again consistently among the ranges associated with high levels of food insecurity. This finding was supported by consistent reports from FGDs of chronic food insecurity: "*These days we are*

badly off in terms of food. You are about to hear of some of us dying because we don't have enough food" – FGD.

Table 7: Severity of food insecurity (AVPS) by survey administration among the Batwa of Kanungu District, Uganda during 6 surveys (January, April, July, November 2013, January, April 2014). R=rainy season; D=dry season.

	Jan 2013 (D)	April 2013 (R)	July 2013 (D)	Nov 2013 (R)	Jan 2014 (D)	April 2014 (R)	Dry	Rainy
Total Responses	130	125	131	124	131	130	388	379
Mean AVPS (Std Dev.) [1]	14.8 (4.7)	13.4 (4.5)	15.8 (6.2)	14.2 (6.1)	14.3 (6.2)	13.6 (6.0)	15.0 (5.8)	13.8 (5.6)
Range of AVPS[1]	0-25	1-22	1-26	0-25	0-23	0-25	0-26	0-25

[1] Adapted vulnerable populations score, as per Patterson et al. (Prep)

Longitudinal surveys indicated that Batwa food security improved modestly over the study period (Figure 5). This modest improvement is unlikely to be related to changing response bias over time since pilot surveys were conducted 4 times in the year previous to data collection for results presented here. FGD participants did not perceive any improvements in food security over this time period (Jan 2013-April 2014). Modest decreases in observed in food insecurity overtime were based on population means (survey data) and may not be perceived at the household level or individual levels, particularly because baseline food insecurity is severe and chronic (Frieden, 2014). Despite this, some participants reported optimism about the future and for enhanced security as a result of improving access to education for their children and increased experience with agrarian practices within their communities. One FGD participant explained,

Today we've learned digging and growing crops to get food compared to when we were in the forest. We can grow our own crops that we think will help us even in the future. Thus the situation might be better in the future than today... This tells that in future and after adopting farming we may not lack food for our families. Because we are trying to adapt to the new life.

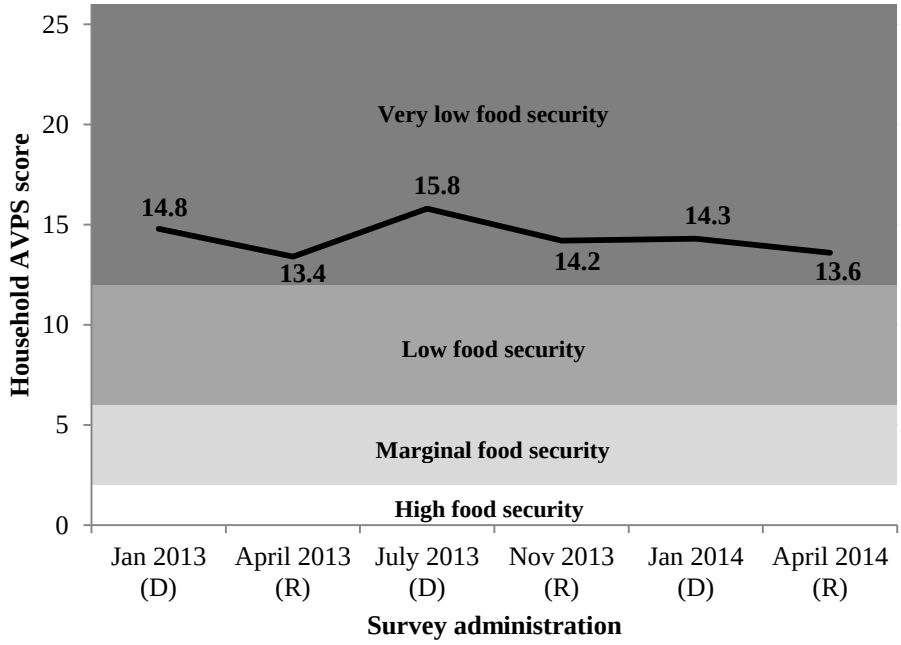

Figure 5: Mean AVPS food insecurity score by season compared to USDA categorizations, Figure demonstrates why variation between seasons was not detectable using the USDA scales: variation occurred by only within the most severe category of food insecurity. The black line denotes the mean AVPS score across surveys

4.5.2 Food insecurity is most severe during the dry season

Food insecurity among households was higher in the dry seasons compared to the rainy and harvest seasons. Even during the harvest season (May/June & November/December), however, food insecurity was severe. USDA food security categories were not able to detect seasonal shifts in the *severity* of food insecurity, given that the majority of households were categorized in the lowest food security category across all seasons. When using the Adapted Vulnerable Populations Score (AVPS), the highest mean scores (indicating higher food insecurity) were consistently recorded during the dry season, and the lowest mean scores (indicating lower food insecurity) were recorded during the wet seasons. FGD participants and

key informants also consistently reported that food insecurity was higher during the dry season compared to the rainy season. One participant stated: *"We are really badly off this [dry] season and we don't have enough to eat"* – FGD. A former nurse from the Bwindi Community Hospital (BCH) noted, for example, that malnutrition cases were higher in the dry season: *"…during the harvest seasons where most of the people have harvested, there are low cases of malnutrition, but during the sunny seasons there are high cases of malnutrition."* Consistent with these reports, the linear model found that *AVPS* food insecurity increased significantly during the dry season by 1.13 points (95% confidence interval: 0.4-1.9) on a scale of 26. Although, the magnitude of the difference was relatively small (Table 8, Figure 5), the model indicated that our binary measure of seasonal variation had a stronger effect than other binary variables with high theorized importance for food security, including adult female education, presence of chronic disease, and access to markets. The study period was characterized as reflecting typical seasons and was meteorologically comparable to the regional average; there were no extreme atypical events that impacted the region or communities over the study period.

Table 8: Multivariable mixed effects linear regression model using random intercepts to control for repeated household measurements and community level clustering for predictors of food security among the Batwa Pygmies of Kanungu District, Uganda, October 2012-April 2014

Model name (description)	Adapted multilevel linear model Co-efficients (95% confidence intervals)
Seasonal variation	
Rainy	Ref
Dry	1.13 (0.4-1.86)**
Control variables:	
Highest adult female education	
Primary complete or above	Ref
Primary incomplete	0.57 (-1.16-2.31)
No formal schooling	1.29 (-.38-2.95)
Presence of chronic disease	
No	Ref
Yes	0.71 (-0.13-1.55)*
Number of dependents	0.51 (0.29-0.73)***
Wealth quartiles[1]	
Least poor	Ref
Poor	-0.72 (-2.71-0.73)
Very poor	1.70 (0.68-2.72)***
Poorest	1.52 (0.40-2.63)**
Crop raiding	
Never	Ref
Sometimes	1.06 (-0.87-3.0)
Often	1.25 (0.04-2.47)*
Access to markets	
Good	Ref
Fair	-1.47 (-3.06-0.12)
Poor	-0.49 (-2.31-1.33)

*0.10 ** 0.05 ***0.01

FGD and KI participants reported that these seasonal differences were primarily due to agricultural cycles revolving around land preparation, planting, growing and harvesting (Figure 6). These cycles are dictated by the rainy and dry seasons; changes in timing, length and intensity of either the rainy or dry months impact harvest yields. FDG and KIs stated that growing crops was the primary strategy employed by households in most communities to access food. During the harvest season, FGD respondents stated that there was greater food availability, lower prices and increased variety of food. Participants highlighted lack of food, particularly during the planting season, at the household, community and regional levels, which caused price increases in the local market. One participant described the pre-harvest experience: *"Even in markets*

there is no food and the little that is there is expensive. When you go to buy sweet potatoes you find yourself being given only 3 sweet potatoes for 1000UGS" –FGD. A coping strategy identified to manage the increases in prices and lack of supply was to harvest crops early. As one participant explained, *"Nowadays we grow yams and on [upon] harvesting them we find they have not yielded. We just get them when they are the same as the way we planted them."* – FGD. Similarly, another participant noted, *"Most times because of hunger we harvest food crops even when they have not matured. When they get finished we go and work for the Bakiga to get food crops. Bakiga always have many fields where we can work to get food and they grow a lot of food crops"* – FGD. The AVPS food security scores captured this strategy as food security begins to improve pre-harvest due to early collection of yields, and continues to increase as regional harvesting begins, improving supply and lowering prices in local markets.

Month	January	February	March	April	May	June	July	August	September	October	November	December
Survey administration	x			x			x				x	
National agricultural trends (National bi-modal cycle)[1]												
Meterological seasons	Dry			Rainy			Dry		Rainy			Dry
Harvest Seasons	Land prep, planting, weeding, growing				Harvest			Land prep, planting, weeding, growing			Harvest	
Food security	Famine or less food				Food			Famine or less food				Food
Batwa lived experience with food security												
Harvest seasons	Land prep, planting, weeding , growing			Early harvest		Land prep, planting, weeding, growing					Harvest	
Food Security	Highly food insecure			Food insecure		Highly food insecure					Food insecure	

[1] *Source: Food Security and Nutrition Working Group (2014) & Famine Early Warning System Network (2014), Key informant interviews, validated by cross-referencing with local data from the Uganda Wildlife Authority for Buhoma and Rushama stations*

Figure 6: Southwestern Uganda seasons and harvesting cycles (two surveys were conducted in January and April, 2013/14 while one survey was conducted in each of July and November, 2013

Although food insecurity was chronic, there were some components of food insecurity that were impacted by seasonal signals more than others. The majority of households reported hunger year round; however, households were more likely to report adult hunger during the dry season than in the rainy season. Notably, the seasonal variation of food *availability* reported by communities and key informants during qualitative data collection was not significant in the quantitative logistic models (Appendix VII): the number of households reporting concern or experiences with running out of food before they could acquire more was not significantly different between the rainy and dry seasons. FGD participants discussed having less *variety* in diet during the dry season, but that availability and quantity of food was chronically low. Beans, *posho* (boiled maize flour), *matoke* (mashed plantain) and potatoes comprised the majority of caloric intake year round, with very limited food diversity at baseline (Figure 7). This lack of seasonal impact documented in the surveys was supported by key informants, noting that Batwa were rarely able to secure meat and mostly subsisted on posho and beans year round. For example, one participant noted, *"Meat is hard to get and it is too expensive. I've spent about a year without eating meat"* – FGD.

Figure 7: Word cloud of food types Batwa households reported eating in Kanungu District, Uganda (2013-14). The more frequently a word is cited by households, the larger and darker its presentation in the image. The world cloud comprises of responses from the food security questionnaire instrument asking what people had eaten the previous day.

Chronic food insecurity was further reflected by the frequency of meals consumed, captured in the 6 survey questionnaires and again during the FGDs. The average number of meals per day was reported as 2.25 (in survey data). During the FGDs when asked how many meals were typical consumed per day, participants frequently reported that 3 meals was the household "ideal" but that this rarely occurred on a day to day basis. One Batwa explained, "*Because we don't always have enough food, we eat 1 or 2 times a day most of the time"* – FGD. Most households did not eat in the morning. Those who did eat a meal in the morning mentioned having a cup of porridge or leftovers from the previous day. Adults in the household reported to frequently go to work without eating; they may receive lunch while working in the field. Batwa reported that at the end of the day, working adults typically prepare a larger meal with their

earnings by buying food or sharing the food they have been given to feed the family. Meal skipping was thus widespread and chronic; the average number of meals per day for a typical Batwa family was low at baseline. Consistent with this, households reported eating less than they felt they should year round. There was some evidence of seasonal variation around this baseline; however, the number of households that reported not eating for a whole day was higher in the dry season compared to the rainy season (Appendix VIII).

4.5.3 Children are protected from seasonal stressors

Consistent with findings of Patterson et al. (Prep) that children are protected from food insecurity by adults in the household, we found evidence that this protection also applied to *seasonal variation* in food insecurity. In contrast to significant seasonal variation in some of the general adult food security questions, only one of the HFSSM items concerned with children varied significantly by season: households reported feeding children higher quality foods during the dry season. While food insecurity was high for both adults and children during all seasons, the burden due to seasonal variation was predominantly borne by household adults. A participant highlighted this protective strategy, "*What I do is, mak[e] sure my children get food and we can even eat it all and don't keep anything for my husband"* – FGD. Reports of re-allocation of food within a household were common *"we also get disturbed when our children are not having enough food. The little food we get we try to give it to the children and still they can't be satisfied. From that, we start thinking a lot and can suffer from pressure (stress), because food is always little"* – FGD. Feeding children was found to be a priority even in the most difficult period of the famine season: *"[t]here are times when we have supper and we can't have lunch the next day and if you have very little food you can serve it to the children and for you [adult] you stay hungry"* – FGD.

Concern for children was prominent throughout the interviews, particularly surrounding health and nutrition. One participant described the effects of chronic food insecurity among children: *"We suffer from snakes of the stomach [worms] and when children are not eating well they become more red [malnutrition]. You find when their cheeks are swollen and their hair turns brown [lightens], all that is because they are not eating well"* – FGD. The concern was noted in both male and female FGDs; however, mothers and adult females within households bore the responsibility for the well-being and feeding of the children. One Batwa mother explained, *"If the child is crying of hunger they cry to the mothers and not their fathers"* – FGD. Some participants mentioned rare circumstances where the burden of increased seasonal food insecurity was shared with children, but these were the exception.

4.5.4 Agricultural yields are constrained by climatic events and socioeconomic barriers

FGD's revealed that households that participated in agriculture and growing crops reported improved food security in the harvesting season, depending on the type of crop a household has grown. FGDs noted that there was a variation in the yields of different crops *"[d]uring the harvest of some crops like millet, you can have enough of it that can sustain you up to the next season. Sometimes we harvest a lot of maize that take us for many days or months"* – FGD. However, the Batwa report being extremely hungry prior to the harvest season: *"[before] the harvesting season, we are in the season of famine"* – FGD. FGD participants and KIs observed increases in access to quantity and quality of food at multiple scales once harvesting begins. First, from their own gardens and then at the regional scale, once crops have matured, there was more food available locally, thus prices for vegetables and fruit decrease.

FGDs and KIs that the increases in availability, access and quality of food during the

harvest season were highly dependent on the absence of extreme weather events (e.g. drought, hail), pests and crop raiding: *"there is a time when our village was hit by a hailstorm and all the crops were destroyed except millet. You would just look around the tea plantations and you'd get blind (something you can't believe) see[ing] all the damage and leaves falling off the tea plants"* – FGD. Extreme weather events in both the dry and rainy seasons were the most frequently mentioned hazards for food security. "*Drought affects us so much. And hailstorms. Imagine you've grown crops like sweet potatoes this month of June when it is shining so much. All the sweet potato vines dry up"* – FGD. Another FGD participant reiterated this: *"During the dry season, many food crops dry up and then you can't have much to eat. It varies because in the last season when we had planted millet it was raining heavily and all the seeds were swept off by running water"* – FGD. Droughts were perceived to be particularly difficult as they impact both food and water security: *"We are affected by drought (a month or longer), like once a year. Dry seasons don't only affect the crops but also our water sources dry up, yet most of the work and activities we do at home all rely on using water"* – FGD. Even for households that were able to grow crops and manage a surplus, excessive rain can prevent safe storage; "*During the harvest season when it is raining so much our crops like beans start re-sprouting/growing in the houses"* – FGD.

While the harvesting season has higher food security than the dry season, the difference in the quantitative surveys data was marginal. Improvements in food security experienced during the harvest season were proportional to the seasonal agricultural yields for each household. Many Batwa households were unable to take advantage of seasonal cycles and subsistence harvesting to improve even seasonal food security. A participant stated that households benefits due to crop harvesting was heterogeneous, "*…we spend about 3 months when we have food to eat. [Having*

enough food to eat] depends on how much food crops [are] grown by different families. If you've grown less food crops then they don't last for long".

FGD participants and KIs, while optimistic about agriculture, extensively discussed both socioeconomic and environmental constraints to success. "*The first season was affected by a lot of rain, the second season was affected by soil infertility and now we are waiting for the third season to see if we can harvest something or not"* – FGD. Land ownership, size and fertility were brought up frequently as constraints on agricultural yields and food security. Although Batwa families do not actually hold land titles, all households are provided with land for agriculture by the BDP. The BDP *"[buys] for them [land], each household [has] at least an acre of land"* – KI from BDP. This land was purchased after extensive commercial agriculture and tea plantations had been developed in the area; FGDs and KIs observed poorer fertility of Batwa plots compared to the regional standard. The FGD and KIs further stated that households were practicing "*...over-cultivation, that depreciates our land. That doesn't yield well..."* because *"...[the Batwa] don't always have enough land to grow crops"* – FGD. Households lamented that "*Because we grow food crops on the same piece of land for a long time, about 10 years, with time we find the yields are less or we end up not harvesting anything."*

Awareness of potential coping strategies was relatively common; crop rotation (including fallow years), crop diversity, cash cropping, animal husbandry, access to most agricultural inputs associated with improved yields, saving during the harvest season and long-term planning, were all identified as potential strategies. Lack of land restricted implementation of coping mechanisms used by the non-Indigenous populations in the regions. Smaller plots, for example, cannot support a diversity of crops; different harvesting cycles of vegetables and legumes can provide food year round if timed appropriately. During a FGD, participants stated they were

unable to produce adequate crop yields, *"[w]e grow food crops and after harvesting we survive on them for about a month and they get finished. We can never grow crops that can last for over a year"*. The FGD participants and KIs remarked that the non-Indigenous neighbouring (Bakiga) population were able to plant both staple and cash crops (coffee, tea), which led to food security and improved cash wealth. FGD participants stated, *"[w]e want to grow all types just like the Bakiga"*. In another FGD a participant said, *"[i]n fact I wish we could be given more land and grow cash crops like tea so we can get income"*. Some households mentioned trying to grow cash crops but faced multiple barriers at the selling phase, and had to forego growing staple crops due to lack of land, putting household food security at risk if cash crops failed or could not be sold. The majority of participants did not report selling crops as the risk of growing cash crops instead of staple crops (which can be eaten) was deemed too high.

Finally, the Batwa are a unique group in the region as they lack traditional knowledge regarding agriculture. A KI from BCH viewed their lack of knowledge and experience as a barrier to food security: *"Even if they had that land, they don't have that knowledge to cultivate their own food and be self-reliable and self-dependent on that food. Whereas… the non-Batwa they have the knowledge… and the land".* Since their eviction from the forest, they have been forced to adapt to agricultural livelihoods, with the associated constraints of accessing tools and seeds, as well as developing community knowledge regarding agricultural cycles, food and cash crops, and harvesting. A key intervention to improve food security identified by both the FGDs and key informants was agricultural training. An FGD participant stated that they wanted "*…a project that can help [us] and look after [us] by sending people to educate [us] on better ways of farming"* – FGD. The BDP KIs reiterated this priority but identified several barriers, including staffing, funding, and the need for long-term and extensive resources to support sustainable

agricultural transition. Therein, poverty remains the dominant barrier to adaptation among the Batwa.

4.5.5 Socioeconomic factors mediate seasonal signals on food security

Socioeconomic factors and their interaction with seasonal variation mediated food security among the Batwa of Kanungu. Employment opportunities were significantly reduced during the rainy season; households had 1.65 higher odds of reporting employed household members during the dry season, but employment was not found to be significant in any of the quantitative food security models. "Digging" (manual agricultural labour), was identified as the primary source of food during the non-harvest season during the FGDs. Most Batwa reported working as manual agricultural labourers but do not work when it is raining: *"That kind of rain also affects our work because it starts in the morning when we want to go and work for food. And once it has started raining you can't move to any field. You just stay in the house and sleep. It rains very early in the morning and you can't even walk in the rain and look for food"* – FGD. Other income generating activities that the Batwa engage in such as collecting firewood, brick making and collecting tea are all also weather dependent.

In some communities located in close proximity to tourist sites KIs and FGDs stated that some households preferred alternative sources of income to acquire food rather than participating in agriculture: *"…some people don't mind[bother] about growing crops*" – FGD. Frustration with lack of yields was a key reason households sought alternative sources of income. An FGD participant highlighted the frustrations associated with low yields: "*[w]e get discouraged that we grow crops and they don't yield… even you would get discouraged. If nothing grew, you would give up too. I always spend a whole day and days digging somewhere close to my home and I am being burned by sunshine but I have never got any yields".* FGDs and KIs mentioned tourism

was an attractive alternative to agriculture as returns are higher and immediate compared to growing crops: "*Crop growing is… practiced but it doesn't help us so fast, like handcrafts. Even if we grow crops when we are not practicing handcrafts we can't have what to eat at that time until the crops grow"* – FGD. Some households did not engage in any agriculture in favour of income through tourism. Compared to the 4000UGS (~$1.30 USD) average for a day of intensive agricultural labour, dancing for one hour can generate 10,000UGS (~$3.33 USD) or higher, and crafts can sell for 5,000 - 50,000UGS (~$1.65-$16.64 USD), depending on customer bargaining and quality. Key informants highlighted two communities in particular where dancing and selling crafts to tourists were identified as important economic activities, often representing more important sources of income compared to livelihoods based predominantly on subsistence agricultural as in other communities. However, tourism was also impacted by seasonal variation: *"[When it is raining] you can't be able to put your handcraft materials for sale because they will get wet. Tourists also fear to move in rain and they can't come to the site. They just go back to their homes, yet you were counting on buying food with the money you would have got from them"* – FGD. Households actively employed through sale of crafts and dancing reported generally not growing enough subsistence food to sustain themselves, and thus they reported using income generation from crafts and dancing to purchase food at markets.

Despite engagement in tourism to generate household income, we found no quantitative evidence of improved food security among households reporting tourism related activities, and this was supported by both FGDs and KIs. We assessed food security by community and saw no increase in food security during the dry season (peak tourism season) for those who reported tourism related activities in the survey. Both the FGDs and KIs noted that while tourism activities generate immediate cash income, this did not necessarily translate into improved short-

or long-term food security since income is allocated not solely to food, and frequently not for lasting food supplies. An FGD participant stated that "*…most of us run to bars when we get a lot of money*". A KI from BDP highlighted this tendency in communities that participate in tourism; *"When its high season, like this season, it is a peak season. There are many tourists who come this way and they (Batwa) usually dance for them; when they (Batwa) are given money …[they] buy food and the rest they drink"* – KI. The quantitative data indicated that alcohol addiction was prevalent in the communities; more than 50% of adults (range across surveys: 56-70% of males) reported drinking regularly across. Spending cash income on alcohol was described by most households during FGDs as a substantial stressor on food security. Men reported higher alcohol use than women, but most households reported high adult alcohol usage regardless of gender. For some families, reducing alcohol consumption during the famine season was a coping strategy; "*if I find a situation getting worse, I stop drinking"* – FGD. However, others mentioned the difficulty of reducing alcohol intake regardless of the severity of food insecurity. A KI from BCH reflected that "*[a]lcohol is a very big problem… [even] in the general population (non-Batwa) there is a problem of alcohol… we have started the alcohol rehabilitation service at this hospital… [to] tackle that seriously*". A KI from the Department of Nutrition at the Ugandan Ministry of Health stated that this pattern is reflected regionally and nationally: "*it's [alcohol] suppressing people's appetite and people are getting addicted to alcohol so they are not eating*".

4.6 Discussion

This study aimed to advance the understanding of how Batwa food systems and food security are impacted by seasonal variation. Our findings indicate that although food insecurity was chronic at baseline, there was evidence of seasonal variation producing a magnified famine season. Children were found to be mostly protected from the seasonal signal on food insecurity,

with the burden of seasonally magnified food insecurity borne predominantly by adults in the household. Notably, the seasonal experience of food insecurity was not homogenous, differing in magnitude based on household livelihood strategy and engagement in subsistence agriculture. These findings are consistent with the body of research on the impact of seasonal variation on subsistence Indigenous populations around the world and specifically the USAID study on household vulnerability to climate change (USAID, 2013). That is, social determinants of health mediate seasonal signals (Berrang-Ford et al., 2012; Sherman, et al., 2015; Sherman & Ford, 2013). These results have implications for our ability to generalize trends in climate change vulnerability even within small areas and seemingly homogenous sub-populations. The inclusion of qualitative methods for place-based research, or consideration of spatial regression (recognizing variation in climate effects based on social mediators) within regional quantitative analysis would be appropriate. Despite wide recognition of the mediating role of social variables on climate vulnerability, quantitative tools explicitly integrating social mediation (spatial regression, effect modification, interaction) are negligible in the climate change and health literature.

Consistent with the findings of Patterson et al. (Prep), the USDA HFSSM was insufficient to measure variation of severe food security experiences; more than 80% of households were classified within the most severe category regardless of season. These results imply that in highly and chronically food insecure populations — those most vulnerable to climate change impacts — the USDA HFSSM standard categorization may not be an appropriate measure of food insecurity. We found that both the scoring and categorization failed to capture variation among the Batwa. Analyses employing the Adapted Vulnerable Populations Score (AVPS), which was designed to detect variation at high levels of food insecurity, were sensitive to seasonal

variations in food security in our analyses. Although the authors attempted to collect the data approximately at the same time each year, the rainy and dry seasons did not occur at identical times and dates of collection administration may have biased the data collected; such challenges typify longitudinal place-based research.

The qualitative interviews with Batwa community members and key informants consistently reported increased severity of food insecurity during the dry season. The role of seasonal variation and climate on agricultural cycles, specifically harvest timing, yields and quality, is well documented (Abdullah & Wheeler, 1985; Eriksen et al., 2009; Hillbruner & Egan, 2008; Mukuve & Fenner, 2015; Tefft, McGuire, & Maunder, 2007; Wossen & Berger, 2015). Sub-Saharan Africa is predicted to face increased droughts, unpredictable precipitation and increased temperatures with climate change (Hussein, 2011; Jankowska et al., 2012; Kotir, 2011; Mukuve & Fenner, 2015; Thompson et al., 2010; Wossen & Berger, 2015). Directly, these climate impacts may reduce the quality and quantity of food grown by the Batwa. Regionally, reduction in the quantity of crops decreases the quantity and diversity of foods available, and increases prices.

The chronically high rates of severe food insecurity reported in Patterson et al. (Prep), and the findings here of increased severity during the dry season, have significant implications for Batwa health. Food insecurity, for instance, has been extensively used as a proxy for malnutrition (Barrett, 2010; Bickel et al., 2000; Thorne-Lyman et al., 2010). Studies examining malnutrition and acute gastrointestinal illness among the Batwa have reported very high burdens of illness (Berrang-Ford et al., 2012; Clark et al., 2014; Lewnard et al., 2014). While the impact of seasonal variation was incremental, even short or minor periods of increased severity of food insecurity can have lasting impacts, particularly on nutrition (Sheffield & Landrigan, 2011).

Food insecurity exacerbates poor health and increases sensitivity and vulnerability to stressors; environmental, social, economic. Increased climatic stressors on the food system will compound very high burden of illhealth and fragile existing food systems among the Batwa (Berrang-Ford et al., 2012; Labbé et al., 2015).

Indigenous populations in Africa and around the world consistently have higher rates of negative health outcomes than their non-Indigenous counterparts (Gracey & King, 2009; Hill, Barker, & Vos, 2007; King et al., 2009). Eviction from their traditional lands and resources, lack of compensation, and a forced agrarian lifestyle transition have not been sufficiently offset by improvements in socioeconomic status and agricultural development to prevent severe inequities in Batwa health compared to the regional average. This narrative of Indigenous loss of land, inequality and struggles adapting to new environments and livelihoods is not unique to the Batwa. Indigenous groups that have been evicted from their traditional lands and lifestyles have been documented globally as facing substantial barriers to adopting new livelihoods, with implications for both physical and mental health (Ford, 2012; Gracey & King, 2009; King et al., 2009; Rigby et al., 2011). Similar to other Indigenous groups who have been relocated or forced into new livelihood options, the Batwa do not have the experience, knowledge, networks or resources that are essential for a successful transition. This is further exacerbated by extreme poverty and continued racial discrimination. While notable improvements have been made since their eviction in 1991, as noted by both the Batwa and key informants, steep social gradients in health persist.

Our qualitative results revealed that the seasonal signal on food security could in theory be partially mediated by participation in cash income labour in addition to, or as an alternative to, growing crops. Agricultural labour, the most readily available form of employment, is

insufficient to enable saving or cash accumulation. Tourism provides notably higher income potential than other types of employment. Geographic location of communities was a key factor in tourism participation. Communities that were situated near the BINP reported engaging in tourism related activities more frequently than those further from the tourism centers. Some households chose not to engage in any agrarian activities in favour of the higher cash income potential from crafting and dancing. Key informants reported concern for households choosing not to participate in cultivation, relying on alternative livelihood strategies increased vulnerability, especially if households spent the money immediately. While employment, particularly in tourism, did provide higher income potential, this was dependent on season; tourism halted and manual labour was not possible when it was raining. As a result, employment opportunities were reduced during the rainy season; similar findings of reduced employment and its impact on food security have been reported in monsoon regions (Hillbruner & Egan, 2008).

Households that relied primarily on agriculture encountered several barriers to improving food security and mitigating the impacts of seasonal variation. The Batwa identified that their lack of agricultural knowledge and experience was a key barrier to achieving high yields. Given these findings, improving knowledge or land access may not improve food security. Effective interventions must address and consider both the lack of wealth and experience in project implementation and entry points.

An alternative to growing personal gardens or engaging in manual labor for others was engaging in tourism. The BDP and BCH have made significant efforts to increase tourism opportunities for the Batwa through the sale of handicrafts, guided hikes and cultural experiences. Access to these opportunities are heterogeneous as communities closest to the BINP were most able to take advantage of this. All participants stated that engaging in tourism resulted

in higher cash income during the tourism season, potentially providing an avenue for the Batwa to increase wealth accumulation. Tourism, while providing higher income potential, is volatile and climate dependent. Selling handicrafts requires cash investments in craft supplies and exposure to tourists willing to buy souvenirs. The Batwa rely on the presence of tourists, regional security to support tourism, and competition with a local handicrafts market. Earnings are not consistent, and improvements in food security are dependent on the ability to save cash. Short-term survival needs, immediate spending and lack of saving prevented improvements in food security from being actualised among Batwa communities. The Batwa, similar to other populations dealing with land dispossession and high poverty, have a high burden of alcoholism. Interventions to improve cash revenue opportunities for improved food security may be unsuccessful unless mainstreamed with consideration of the determinants, prevalence, and implications of alcoholism with Batwa communities.

While suitable adaptation strategies for vulnerable populations to cope with climatic impacts and increase their resilience has been established as a priority, it has been distinguished from development, and many funding priorities have specified that adaptations specifically address climatic impacts (Smith et al., 2011; Tirpak & Parry, 2009). Critics of this approach have highlighted the fact that current poor health and poverty are the largest contributors to sensitivity to climate impacts (Campbell-Lendrum et al., 2015; Haines et al., 2014; Neira et al., 2014). Given the results presented here, the Batwa are highly vulnerable and sensitive to seasonal variation. Increased variability predicted with climate change with further increase the burden on food security among the Batwa. Multi-scale interventions are required in all Batwa communities to improve current food security and reduce poverty. Improving Batwa food security would not only reduce the prevalence of undernutrition but would benefit and improve overall health

(Hosking & Campbell-Lendrum, 2012). The complexity and heterogeneity of seasonal impacts found here supports the use of mixed methods in place-based research. While quantitative analysis is useful to identify population level dynamics and significant effects, qualitative research methods can provide insight into causal mechanisms and explanations for outliers. Further research examining the impact of seasonal variation on agricultural cycles and nutritional outcomes would provide valuable insight for reducing vulnerabilities and implementing appropriate targeted interventions.

Chapter 5: Discussion & conclusions

This thesis examined the seasonal variation of the food system and food security among the Batwa to understand the current risks and inform future adaptation and public health policy planning in Kanungu District, Uganda. Food security plays an essential role in health and well-being. Food insecurity is a leading cause of malnutrition and hunger. Climate change is expected to impact global food security; heterogeneous distribution of climatic events such as unpredictable precipitation, extreme weather, higher temperatures and increased droughts will impact populations differently. Subsistence populations that rely on agriculture have been highlighted as extremely vulnerable to adverse climatic events. Indigenous populations may face additional stressors due to their experiences with systematic inequality and poorer health outcomes than their non-Indigenous counterparts. A quantitative modelling study was conducted to investigate prevalence, determinants and scale of food insecurity (Chapter 3). This was complemented here by a mixed methods study examining the current relationship and lived experience between seasonal variation and food security (Chapter 4). This chapter reviews the main findings of both studies, reflects on the studies' limitations and discusses potential research avenues moving forward.

5.1 Main findings

The aim of this thesis was to assess the role of seasonal variation in the prevalence, determinants and experience of food insecurity among the Batwa. The main objectives were to:

1) Estimate the prevalence of food insecurity among the Batwa of Kanungu District
2) Identify the determinants and food insecurity among the Batwa of Kanungu District
3) Examine the scale of food insecurity among the Batwa of Kanungu District
4) Quantify, critically assess and characterize seasonal variation in Batwa food systems

Chapter 2 reviewed the literature and placed this thesis within the field of health geography. Research on Indigenous health is disproportionately low despite the higher rates of negative health outcomes, lack of access to care and inequality that Indigenous populations face. Poor or vulnerable populations are expected to face a disproportionate burden of the impacts of climate change. Research on current health vulnerabilities to climatic, seasonal, or meteorological variability is imperative to support appropriate and effective adaptation to reduce current sensitivities and improve long term resilience. Health geography provides a valuable framework to assess health, inequality, and climate at multiple scales. This chapter illustrated the importance of examining the determinants, scale, seasonal variation and the lived experience of food insecurity to best inform public health policy and future planning adaptation for the Batwa of Kanungu District, Uganda.

Chapter 3, a quantitative modelling manuscript, addressed objectives 1-3. The prevalence of food insecurity among the Batwa was found to be one of the highest in the published literature, with more that 95% of households being classified as severely food insecure (USDA household food security survey module's worst category) over six surveys between January 2013 and April 2014. A new scale, *Adapted Vulnerable Populations Score* (AVPS), was developed to capture variation of food security occurring within the USDA's worst category. The model found that seasonal variation, adult female education, wealth, experiences with crop raiding and proximity to markets were significant determinants of food security for the Batwa. However, due to the homogenous nature of severe poverty among Batwa households, the most significant determinants of food insecurity found in our models explained little of the variation in food security. The study found that key determinants of health did not vary when using household as

the scale of analysis. Social mediating effects, including lack of social capital and access and exposure to inequality are invariant at the household and community levels for the Batwa.

Chapter 4, a mixed methods manuscript, addressed objective 4. The best fit model from Chapter 3 indicated that the dry season increased the severity of household food insecurity. While food insecurity was chronically high throughout the year, both the quantitative and qualitative data indicated that food insecurity was most severe during the dry season. Households struggled with key indicators of food insecurity, such as difficulty in acquiring sufficient quantities of food and reporting eating lower quality foods year round, and the severity of these increased during the dry season. Focus group discussions revealed that several factors mediated the impact of seasonal variation, including employment, wealth and community location. These findings indicate that the impact of seasonal variation is spatially non-stationary and that social determinants of health mediate the impact of climate variability on food security.

This thesis supports the body of knowledge and research that Indigenous health and food systems are vulnerable to climate change and that social determinants of health may act as modifiers to climate variability. The homogeneity of poverty and lack of variation in food insecurity indicates this population will face a higher risks compared to their non-Indigenous neighbours. The current sensitivity to the dry season found here has serious implications for future food security. Any additional stressors on yields, or delays between harvest seasons, could result in higher levels of malnutrition and exacerbate other climate sensitive health outcomes. For example among the Batwa, malnutrition has been linked to increased incidence of malaria (Lewnard et al., 2014). The findings here support the calls for current interventions that improve food security and health and reduce poverty as climate change adaptation strategies.

5.2 Study limitations

There are a few limitations that I will address here. First, measuring food security is difficult and the measure used here was based on self-reporting and perceptions. Some studies have found that the level of food insecurity may be over-emphasized to receive potential aid. However, extensive pilot work was conducted in an effort to integrate communities into the research process and prevent this. Second, the survey administration was conducted during the mid-point of both the dry and wet seasons. While food insecurity was worst during the dry season, the measures of food security taken during the wet seasons did not completely correspond with the harvesting seasons. The harvest season is dependent on the climatic cycles and can fall at varying times dependent on the year. The Batwa may have higher food security than captured here-in during their peak harvest time. Additional analysis of seasonal variation was limited due to lack of environmental and weather data. Third, positionality of the researchers may have impacted answers. Every effort was made to negotiate this positionality and reduce the asymmetry between the researchers and participants. However, given the inequality this community faces, power imbalance may have impacted responses by community members.

5.3 Directions for further research

The scale dependence of food insecurity among the Batwa, may indicate the scale dependence of other burdens of disease. A comparative study between the Batwa and the Bakiga (non-Indigenous) may provide valuable insight into the determinants of health outcomes in the District. Demonstrating the health inequalities the Batwa face would support local efforts to get more healthcare and access funding and recognition from the Ugandan government of Indigenous rights.

While food insecurity was found to be homogenous, the impact of seasonal variation was modified by social factors. Additional research into quantifying the impact of social mediation on climate signals could provide valuable information for intervention entry points. Participants and key informants repeatedly commented on the interaction between food security and health outcomes, often describing it as a negative cycle. Further research into the burden of disease and food insecurity among the Batwa could inform public health outreach and education strategies.

The Batwa face high risks of increased disease burden in addition to the negative impacts of climate change. Intervention studies could provide immediate adaptation support while building evidence for broader project implementations. The Batwa identified agricultural knowledge workshops, community cooperative and animal husbandry as appropriate food security interventions.

While the Batwa do have extremely high burdens of illness and poverty, they have an extensive history of adaptation and resilience. Moving forward, the Batwa will need external support to negate historical injustices and partnerships strengthening their capacity.

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Appendices

Appendix I – Food security, household and individual questionnaires

EBIBUUZO EBIRIKUKWATA AHA NTEBEKANISA/ENTEEKA Y'EBY'OKURYA OMU MAKA | HOUSEHOLD FOOD PREPARATION HEAD QUESTIONNAIRE

EBIBUUZO EBI N'EBYO'GWO OMUNTU AINE OMWOOGA GW'OKUTEEKA N'OKUTEBEKANISA EBY'OKURYA OMU MAKA	**THESE QUESTIONS ARE FOR THE PERSON GENERALLY IN CHARGE OF FOOD PREPARATION**

EKICWEKA A: EBIRI KUKWATA AHA KYARO/OMUNTO OGWO ORIKUBUUZIBWA	**EBIBUUZO IKUMI NA BISHATU**	**PART A:** Demographics	**12 questions**
EKICWEKA D: ENTEEKATEEKA Y'EBY'OKURYA OMU MAKA	**EBIBUUZO IKUMI NA MWENDA**	**PART E:** Food security	**17 questions**
EBIBUUZO EBIRI KUHENDERA EKIGAANIIRO	**EBIBUUZO BIBIRI EBY'OKUHENDERA EKIGAANIRO**	**Completion Questions**	**2 questions**
EBIBUUZO BYOONA HAMWE/ OMUHENDO	**EBIBUUZO ASHATU NA BINA**	**Total:**	**31 questions**

EKICWEKA A - EBIRIKUKWATA AHA KYARO/EIHANGA/OMUNTU OGWO ORIKUBUUZIBWA

PART A – Demographics

ORIKUBUZA: EIJUKA EBI!

- ☐ SHOBORORA NGU EBIMULA-BAMBEHO NEBYANYU, TIHARITTO'NDIJJO ORABIMANYE
- ☐ BUZA KUBARABEBINE EBIBUZO BYONA OTAKATANDICHIRE

1. ORIKUBUUZIBWA YAIKIRIZA?
   - ☐ YAIKIRIZA KUBUUZIBWA
   - ☐ TIYAIKIRIZA KUBUUZIBWA
2. EKICWEKA (EKYARO/OMWANYA OGU): _____
3. EBIRO BY'OKWEEZI: _____ (dd; mm; yr)
4. IZIINA RY'OGWO ORI KUBUUZA EBIBUUZO EBI: _____
5. OBUHANGWA BW'OMUNTU:
   - ☐ MUSHAIJA
   - ☐ MUKAZI
6. OINE EMYAKA ENGAHI? _____
7. EIZIINA RY'ORIKUBUUZIBWA *:* _____
8. AKAMANYISO K'OMUNTU ORIKUBUUZIBWA*:* _____
9. AKAMANYISO K'AMAKA*:*_____
10. INDICATE IF A NEW CODE WAS GENERATED FOR THIS PARTICIPANT
    - ☐ EEGO
    - ☐ INGAAHA

    CODE APPROVED BY SUPERVISOR: _____

Interviewer: Remember this!

☐ Explain the answers are confidential

☐ Ask the respondent if they have any questions before you begin.

Informed consent:

☐ Respondent agrees to be interviewed

☐ Respondent does not agree to be interviewed

Location (i.e. settlement): _____

Today's Date: ____ (dd; mm; yr)

Interviewer name: _____

Sex:

☐ Male

☐ Female

What is your age: _____

Participant name:_____

Individual ID:_____

Household ID: _____

Indicate if a new code was generated for this participant:

☐ EEGO

☐ INGAAHA

Code approved by supervisor: _____

EKICWEKA D - ENTEEKATEEKA Y'EBY'OKURYA OMU MAKA

PART D – Food Security

1. OINE EMYAKA IKUMI NA MUNAANA N'OKWEYONGERAYO AHAIGURU?
   - ☐ EEGO *[GUMIZAMAU]*
   - ☐ INGAAHA *[*HEZA,/HENDERA EKIGAANIIRO*]*

Are you 18 years old or older?
- ☐ Yes [Continue]
- ☐ No [End of the Food Security Food Questionnaire]

OMU KICWEKA EKIRIKUGARUKAHO, NOOSHABWA KUGARUKAMU EBIBUUZO BIKYE EBIRIKUKWATA AHA BUREMEEZI BW'OKWEHISYAHO EBY'OKURYA BIRIKUMARA OMUKA. BIMWE AHA BIBUUZO EBI TIBYOROBI KANDI NOOBAASA KUGUMIRWA OMU KUBIGARUKAMU. KWONKA EBIBUUZO EBI NI BIKURU OMU KWETEGYEREZA EBIZIBU BY'AMAKA OMU KICWEKA EKI N'OMUKUTAHO OBURYO BW'OKUYAMBA EKICWEKA KUTUNGUURA OBWINGI N'ENTEEKATEEKA Y'EBY'OKURYA. BYONA EBI ORATEISE, EBITEEKATEEKO BYAWE AHA NSHONGA EZI NINBYIJA KUKUMWA NKEKIHAMA. TIHARIHO EIZIINA RY'OMUNTU WEENA OBUUZIBWE ERIRIKWIJA KUMANYWA ABEEBEMBEZI NINGA GAVUMENTI. OINE ORUSA KWIKIRIZA KUGARUKAMU NINGA KWANGA KUGARUKAMU EKIBUUZO EKYAKUHA OBUREMEEZI BWINGI.

The next section asks questions about being able to afford food for your household. Some of the questions are very personal and may be difficult for you to answer. However, this information will help researchers, as well as community and health leaders to have a better understanding of problems facing families in this community and to design better programs to improve food security. Like the rest of the questionnaire, this information is strictly confidential and no names will be released to the community or government. You are free to refuse to answer any question.

EKICWEKA 1

AHABIBUZO EBI (15-17), NGAMBIRA KUKIRABE KIRIKUCHIRA KUBAHO, KUBAHO RINIWE NARIME NINGA KITAKABAGAHO OMUKA YAWE OMUMYEZI ESHATU EHINGWIRE.

EBIBUZO EBI NEBYO'MUNTU ORIKUTEBEKANISA EBYOKURYA.

SECTION 1

FOR EACH OF THESE QUESTIONS, PLEASE TELL ME HOW MANY DAYS THE FOLLOWING IS TRUE FOR YOUR HOUSEHOLD IN THE LAST THREE MONTHS.
THESE QUESTIONS ARE FOR THE PERSON GENERALLY IN CHARGE OF FOOD PREPARATION

2. OMU MYEZI ESHATU EHWEIRE, OBAIRE WAATUNGIREHO OKWERARIKIRIRA NGU EBY'OKURYA AHABW'AWE NA BANTU B'OMUKA YAAWE BYAZA KUHWAHO OTAKATUNGIRE AHO KWIHA EBINDI?
   - ☐ NIKIRA KUBAHO
   - ☐ RIMWE NA RIMWE
   - ☐ INGAAHA
   - ☐ TINDIKUMANYA
   - ☐ YAAHUNAMA

In the last 3 months, did you ever **worry** whether the food for you and your family would run out before you could get more?
- ☐ Often
- ☐ Sometimes
- ☐ Never
- ☐ Don't know
- ☐ No response

3. OMU MYEZI ESHATU EHWEIRE, KIKABAHO NGU EBY'OKURYA EBI WAABIRE OINE/OGUZIRE TIBIRABAMARIRE BWIRE OBU WAABIRE NOOTEEKETEEKA HAZA WAYESHANGA OTARIKUBAASA KUTUNGA/KUGURA EBINDI?
   - ☐ NIKIRA KUBAHO
   - ☐ RIMWE NA RIMWE
   - ☐ INGAAHA
   - ☐ TINDIKUMANYA
   - ☐ YAAHUNAMA

In the last 3 months, did it happen that the food you Bought/obtained **didn't last** enough time and you couldn't buy/obtain more?
- ☐ Often
- ☐ Sometimes
- ☐ Never
- ☐ Don't know
- ☐ No response

4. OMU MYEZI ESHATU EHWEIRE OBIRE NOKIRA KURYA EBYOKURYA

In the last 3 months, did you not

BY'EMIRENGO MINGI?
- ☐ NIKIRA KUBAHO
- ☐ RIMWE NA RIMWE
- ☐ INGAAHA
- ☐ TINDIKUMANYA
- ☐ YAAHUNAMA

have enough **varied** meals to eat?
- ☐ Often
- ☐ Sometimes
- ☐ Never
- ☐ Don't know
- ☐ No response

5. EKA YAAWE: MURAIRE KI NYOMWABAZYO? IJUKA KUBUUZA "HARIHO EKINDI EKI MURAIRE; OMU MIRINGO Y'EBY'OKURYA NK'ENYAMA, AMATE, EBIJUMA, EMBOGA. HANDIIKA EMIRINGO Y'EBY'OKURYA EYAYOREKWA

_____ _____ _____
_____ _____ _____
_____ _____ _____

What did your family eat yesterday?
Interviewer Prompt: prompt the participant by asking "And what else did your family eat yesterday?" Also prompt on food groups such as meat, dairy, fruit, and vegetables.

6. EBI NIBYO BY'OKURYA EBI MURIKURYA BUTOOSHA?
- ☐ EEGO
- ☐ INGAAHA (YOREKA ENSHONGA AHANKI OBUNDI EBY'OKURYA NIBIHINDUKA): _____
- ☐ TINDIKUMANYA
- ☐ YAAHUNAMA

Is this what your family typically eats in a day?
- ☐ Yes
- ☐ No (specify the reason why):
- ☐ Don't know
- ☐ No response

7. How many meals does your family typically eat in a day? (specify number): _____.

How many meals does your family typically eat in a day? (Specify number:_____)

In the last 3 months, did you or other adults in your household ever **cut** the size of your meals or **skip** meals because there wasn't enough food at home?
- ☐ Yes
- ☐ No
- ☐ Don't know
- ☐ No response

8. OMU MYEZI ESHATU EHWEIRE, IWE NINGA ABANTU ABAKURU OMUKA MUBAIRE MWAHARIRIZIBWE KUKYENDEEZA AHA BUHANGO BW'EKIHURO AHA SOHAANI NINGA KUGURUKAMU EBIHURO AHABW'OKUGIRA NGU EBY'OKURYA BIKABA BITARIKUMARA?
- ☐ EEGO
- ☐ INGAAHA
- ☐ TINDIKUMANYA
- ☐ YAAHUNAMA

9. How many days did you have to cut or skip meals because there wasn't enough food at home?
- ☐ A few days in the month
- ☐ About half the days in the month
- ☐ Most of the days in the month
- ☐ TINDIKUMANYA
- ☐ YAAHUNAMA

How many days did you have to cut or skip meals because there wasn't enough food at home?
- ☐ A few days in the month
- ☐ About half the days in the month
- ☐ Most of the days in the month
- ☐ Don't know
- ☐ No response

10. OMU MYEZI ESHATU EHWEIRE, IWE NINGA ABANTU ABAKURU OMUKA MUBAIRE NIMURYAHO KAKYE KURUGA AHA KUMURYA BURIIJO AHABW'OKUGIRA NGU EBY'OKURYA TIBIRI KUMARA?
- ☐ EEGO
- ☐ INGAAHA

In the last 3 months, did you or other adults in your household ever **eat less than you felt you should** because there wasn't enough food at home?
- ☐ Yes
- ☐ No

☐ TINDIKUMANYA
☐ YAAHUNAMA

☐ Don't know
☐ No response

11. OMU MYEZI ESHATU EHWEIRE, IWE NINGA ABANTU ABANDI ABAKURU OMU KA EGI MUKASIBAKWE/MUKARARAKWE MUKEESIIBYAKWO AHABW'OKUBA HAKABA HATARIHO BY'OKURYA BIRI KUMARA OMUKA?
    ☐ EEGO
    ☐ INGAAHA
    ☐ TINDIKUMANYA
    ☐ YAAHUNAMA

In the last 3 months, were you or other adults in your household ever **hungry** but didn't eat because there wasn't enough food at home?
☐ Yes
☐ No
☐ Don't know
☐ No response

12. OMU MYEZI ESHATU EHWEIRE, IWE NINGA ABANTU ABANDI ABAKURU OMU KA EGI MUHURURUKIRE AHABW'OBUTAGIRA SENTE ZIRIKUMARA KUGURA EBY'OKURYA?
    ☐ EEGO
    ☐ INGAAHA
    ☐ TINDIKUMANYA
    ☐ YAAHUNAMA

In the last 3 months, did you or other adults in your household **lose weight** because you didn't have enough money for food?
☐ Yes
☐ No
☐ Don't know
☐ No response

13. OMU MYEZI ESHATU EHWEIRE, IWE NINGA OMUNTU ONDIIJO OMUKURU MUKASIBAUWE/MUKARARNAKWE AHABW'OKUGIRA NGU OMUKA HAKABA HATARIMU BY'OKURYA BIRI KUMARA?
    ☐ EEGO (AMAZOOBA AGU EKYO KIBAIREHO): _____
    ☐ INGAAHA
    ☐ TINDIKUMANYA
    ☐ YAAHUNAMA

In the last 3 months, did you or other adults in your household ever **not eat for a whole day** because there wasn't enough food in the home?
☐ Yes
☐ No
☐ Don't know
☐ No response

14. How many times did you not eat for a whole day in the month?
    ☐ A few days in the month
    ☐ About half the days in the month
    ☐ Most of the days in the month
    ☐ TINDIKUMANYA
    ☐ YAHHUNAMA

How many times did you not eat of whole day in the month?
☐ A few days in the month
☐ About half the days in the month
☐ Most of the days in the month
☐ Don't know
☐ No response

EKICWEKA 4

EBIBUUZO EBIRI KUGARUKAHO NIBIKWATA AHA BAANA OMU KA EGI ABARI AHANSI Y'EMYAKA IKUMI NA MUNAANA Y'OBUKURU

AMAKA AGATIINE BAANA OMU MYAKA EGYO, NINGA AGIINE ABAANA BAKURU ABARI KUHINGUZA OMURI IKUMI NA MUNAANA, HEZA,/HENDERA EKIGAANIIRO

SECTION 4
THE NEXT QUESTIONS ARE ABOUT PERSONS LIVING IN THE HOUSEHOLD WHO ARE UNDER 18 YEARS OF AGE

HOUSEHOLDS WITH NO CHILDREN UNDER 18, END QUESTIONNAIRE

15. OMU MYEZI ESHATU EHWEIRE, HARIHO OBU OHARIRIZIBWE KURIISA ABAANA BAAWE EBY'OKURYA BY'OMUTIINDO GWA HANSI AHABW'OKUBA EBYO NIBYO BY'OKURYA EBI OBAIRE NOOBAASA KUBAHEREZA?
    ☐ NIKIRA KUBAHO
    ☐ RIMWE NA RIMWE

In the last 3 months, were there times when you could only feed your children less expensive/ **lower quality foods** because food ran out at home and it was difficult to buy/obtain higher quality food?
☐ Often

☐ INGAAHA
☐ TINDIKUMANYA
☐ YAAHUNAMA

16. OMU MYEZI ESHATU EHWEIRE, HAINE OBU OBAIRE OTAINE BY'OKURYA BY'EMIRINGO MIINGI NAHABW'EKYO ABAANA BAAWE TIBAABAASA KURYA BY'OKURYA EBY'O?

☐ NIKIRA KUBAHO
☐ RIMWE NA RIMWE
☐ INGAAHA
☐ TINDIKUMANYA
☐ YAAHUNAMA

17. OMU MYEZI ESHATU EHWEIRE, HARIHO AMAZOOBA OBU ABAANA BAAWE BABAIRE BATARIKUTUNGA EBY'OKURYA BIRIKUBAMARA AHABW'OKUBA NAIWE OKABA OTARIKUTUNGA BIRIKUMARA?

☐ NIKIRA KUBAHO
☐ RIMWE NA RIMWE
☐ INGAAHA
☐ TINDIKUMANYA
☐ YAAHUNAMA

18. OMU MYEZI ESHATU EHWEIRE OHARIRIZIIBWE KUKYENDEEZA AHA MUGABO/OBWINGI BW'EBY'OKURYA EBI OBAIRE NOOGABURIRA ABAANA BAAWE AHABW'OKUBA EBY'OKURYA BIBAIRE BITARIKUMARA?

☐ NIKIRA KUBAHO
☐ RIMWE NA RIMWE
☐ INGAAHA
☐ TINDIKUMANYA
☐ YAAHUNAMA

19. OMU MYEZI ESHATU EHWEIRE, ABAANA BAAWE BABAIRE BAGURUKIREHO EKIIHURO/EBY'OKURYA AHABW'OBUTABA NA BY'OKURYA OMUKA?

☐ EEGO (EMIRUNDI EI EKYO KIBAIREHO): _____
☐ INGAAHA
☐ TINDIKUMANYA
☐ YAAHUNAMA

20. How many days in the last month did your children have to skip meals?

☐ A few days in the month
☐ About half the days in the month
☐ Most of the days in the month
☐ TINDIKUMANYA
☐ YAHHUNAMA

21. OMU MYEZI ESHATU EHWEIRE, ABAANA BAAWE BABAIRE BASIBIREKWE AHABW'OBUTAGIRA BY'OKURYA OMUKA?

☐ Sometimes
☐ Never
☐ Don't know
☐ No response

In the last 3 months, were there times when you did not have enough to feed your children with **varied**, balanced and healthy meals?

☐ Often
☐ Sometimes
☐ Never
☐ Don't know
☐ No response

In the last 3 months, where there times when your children were **not eating enough** because you just couldn't buy/obtain enough food?

☐ Often
☐ Sometimes
☐ Never
☐ Don't know
☐ No response

In the last 3 months, did you have to **reduce** your children's food portions because there wasn't enough food at home?

☐ Often
☐ Sometimes
☐ Never
☐ Don't know
☐ No response

In the last 3 months, did any of your children have to **skip** meals because there was not enough food at home?

☐ Yes
☐ No
☐ Don't know
☐ No response

How many days in the last month did your children have to skip meals?

☐ A few days in the month
☐ About half the days in the month
☐ Most of the days in the month
☐ TINDIKUMANYA
☐ YAHHUNAMA

In the last 3 months, did any of your children ever go **hungry**

☐ EEGO
☐ INGAAHA
☐ TINDI KUMANYA
☐ YAAHUNAMA

because there was no food at home?
☐ Yes
☐ No
☐ Don't know
☐ No response

22. OMU MYEZI ESHATU EHWEIRE, ABAANA BAAWE BABAIRE BASIBIREKWE KUMARA EIZOOBA RYONA AHABW'OBUTABAHO BY'OKURYA OMUKA?
☐ EEGO
☐ INGAAHA
☐ TINDI KUMANYA
☐ YAAHUNAMA

In the last 3 months, did any of your children **not eat for a whole day** because there was no food at home?
☐ Yes
☐ No
☐ Don't know
☐ No response

EKYI NIKYO KIBUUZO KYAHA MUHERU ***That was my last question***

23. OINE EKINDI KIBUUZO EKI ORIKWENDA KUMBUUZA NINGA EKINDI KINTU EKI ORI KWENDA KUNSHOBORE RAHO? *ORI KUBUUZA EBIBUUZO? HANDIIKA EBYO BYONKA EBI EBIRI KUKWATA AHA NSHONGA EZI*

Do you have any other questions or comments? *Interviewer: type any additional comments the respondent has said that are relevant*

SHOBORORA

Comments:

_____
_____
_____
_____
_____

YEBARE MUNONGA. EBIGARUKWAMU EBI WAAHAYO NIBAIJA KUTEERANWA N'EBYA BANDI BANTU ABAABUZIBWA OMU KUCOONDOOZA OKU. BWANYIMA HARUGYEMU AMAKURU AHA MAGARA GA BANTU OMU KICWEKA EKI. EBYO EBIRAYEGWE AHA MAGARA GA BANTU, NIBIIJA KUGUMA BIRI EBYEKIHAMA KANDI TIHARIHO EIZIINA RY'OMUNTU N'OMWE ERIRAMANYWE ABANDI BANTU NINGA GAVUMENTI.

With all other participants to give us information about the health of people throughout the community. The information you provided is strictly confidential and no names will be released to the community or government.

YEBARA MUNONGA KUKWATANISA NAITWE ***Thank you again for your time and cooperation.***

24. EKIGAANIIRO KYAHWA SHHAHA:
_____

Time finished: _____

IHACC

EBIBUUZO BYA MUKURU W'EKA | HOUSEHOLD HEAD QUESTIONNAIRE

EKICWEKA A: EBIRI KUKWATA AHA KYARO/OMUNTO OGWO ORIKUBUUZIBWA	**EBIBUUZO IKUMI NA BISHATU**	**PART A:** Demographics	**13 questions**
EKICWEKA C: EBIRIKURETAHO EBIZIBU, ENDWARA N'AMAGARA MABI	**EBIBUUZO ABIRI NA MUSHANJU**	**PART C:** Risk factors	**27 questions**
EBIBUUZO EBIRI KUHENDERA EKIGAANIIRO	**EBIBUUZO BIBIRI EBY'OKUHENDERA**	**Completion Questions**	**2 questions**
BYOONA HAMWE		**Total:**	**42 questions**

EKICWEKA A - EBIRIKUKWATA AHA KYARO/EIHANGA/OMUNTU OGWO ORIKUBUUZIBWA

PART A – Demographics

ORIKUBUZA: EIJUKA EBI!

☐ SHOBORORA NGU EBIMULA-BAMBEHO NEBYANYU, TIHARITTO'NDIJJO ORABIMANYE

☐ BUZA KUBARABEBINE EBIBUZO BYONA OTAKATANDICHIRE

Interviewer: Remember this!
☐ Explain the answers are confidential
☐ Ask the respondent if they have any questions before you begin.

1. ORIKUBUUZIBWA YAIKIRIZA:

☐ YAIKIRIZA KUBUUZIBWA
☐ TIYAIKIRIZA KUBUUZIBWA

Informed consent:
☐ Respondent agrees to be interviewed
☐ Respondent does not agree to be interviewed

2. EIHANGA:

☐ Canada
☐ Peru
☐ Uganda

Country:
☐ Canada
☐ Peru
☐ Uganda

3. EKICWEKA (EKYARO/OMWANYA OGU):_____

Location (i.e. settlement):

4. EBIRO BY'OKWEEZI:_____ (dd; mm; yr)

Today's Date:
(dd; mm; yr)

5. IZIINA RY'OGWO ORI KUBUUZA EBIBUUZO EBI: _____

Interviewer name:

6. OBUHANGWA BW'OMUNTU:

☐ MUSHAIJA
☐ MUKAZI

Sex:
☐ Male
☐ Female

7. OINE EMYAKA ENGAHI? _____

What is your age? _____

YAABA ATARIKUMANYA MYAKA YE, GYERANISIZA AHA RURENGO ORU

☐ AHANNSI Y'OMWAKA GUMWE
☐ OMWAKA GUMWE KUHIKA AHA MYAKA ETAANO
☐ EMYAKA MUKAAGA KUHIKA AHA MYAKA IKUMI N'EBIRI
☐ EMYAKA IKUMI N'ESHATU KUHIKA AHA MYAKA ABIRI N'ESHATU
☐ EMYAKA ABIRI N'ENA KUHIKA AHA MYAKA ASHATU N'ETAANO
☐ EMYAKA ASHATU NA MUKAAGA KUHIKA AHA MYAKA ANA NA MUSHANJU
☐ EMYAKA ANA NA MUNAANA KUHIKA AHA MYAKA ATAANO NA MWENDA
☐ EMYAKA NKAAGA, NINGA AHAIGURU
☐ INGAAHA

If unknown, estimate age range:
☐ *< 1 year*
☐ *1-5 years*
☐ *6-12 years*
☐ *13-23 years*
☐ *24-35 years*
☐ *36-47 years*
☐ *48-59 years*
☐ *≥60 years*
☐ *No response*

8. EIZIINA RY'ORIKUBUUZIBWA*:* _____

Participant name:_____

9. AKAMANYISO K'OMUNTU ORIKUBUUZIBWA :_____

Individual ID*:*_____

10. AKAMANYISO K'AMAKA*:*_____

Household ID: _____

11. ORI MUKURU W'EKA EGI?

☐ EEGO

Are you the household head?
☐ Yes

☐ INGAAHA
☐ TARIKUKIHAMYA KURUNGI
☐ YAAHUNAMA

☐ No
☐ Unsure
☐ No response

EKICWEKA C - EBIRIKURETAHO EBIZIBU, ENDWARA N'AMAGARA MABI

PART C Risk factors

ORI KUBUUZA EBIBUUZO EBI: EBIBUUZO OMU KICWEKA EKI NOOBAASA KUGARUKAMU KURUGIRIRA AHARI EBY'O EBI ORI KUREEBA, BAITU WAABA NOOKIBAASA.

Interviewer: The following questions may be completed by the interviewer, if appropriate and possible.

12. NIMUKOZESA KI KUTEEKA EBY'OKURYA? (*RONDA KIMWE KYOKNA*).
    - ☐ PARAFIINI
    - ☐ AMAKARA
    - ☐ ENKU
    - ☐ EBINDI, SHOBORORA: _____
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

What type of fuel does your household mainly use for cooking? Select one.
- ☐ *Kerosene*
- ☐ *Charcoal*
- ☐ *Firewood/ straw*
- ☐ *Other (specify): _____*
- ☐ *Unsure*
- ☐ *No response*

13. OINE AMAIZI G'OKUNAABA OMU NGARO HAIHI N'ENJU?
    - ☐ EEGO
    - ☐ INGAAHA
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

Are there hand washing facilities near the house?
- ☐ *Yes*
- ☐ *No*
- ☐ *Unsure*
- ☐ *No response*

14. *KU ARARE YAAGIRA NGU EEGO OMU KIBUUZO 17,* HARIHO ESAABUNI AHA MWANYA OGUKOZIRWE KUNAABIRWAMU ENGARO?
    - ☐ EEGO
    - ☐ INGAAHA
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

If yes to question 17, Is there soap at the washing facility near the house?
- ☐ *Yes*
- ☐ *No*
- ☐ *Unsure*
- ☐ *No response*

ORIKUBUUZA EBIBUUZO: BUUZA KANDI OTUNGYE EBIGARUKWAMU

Please ask the participants the following questions.

15. OMU NJU NIMUTUURAMU ABANTU BANGAHI MWENA HAMWE, OGAITSIRE NA BAANA BOONA?
    - ☐ OMUHENDO GW'ABANTU MWEENA OMU NJU EGI: _____ ABANTU MWEENA
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

How many people, including yourself, live with you in your household now, including children?
- ☐ Specify: _____people
- ☐ Unsure
- ☐ No response

16. ENJU ERIMU EBISHENGYE BINGAHI?
    - ☐ OMUHENDO GW'EBISHENGYE: _____
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

How many rooms are there in your house?
- ☐ Specify: _____rooms
- ☐ Unsure
- ☐ No response

17. NI EBISHENGYE BINGAHI AHARI EBYO EBIRIKURAARWAMU ABANTU?
    - ☐ OMUHENDO: _____ EBISHENGYE BYOONA
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

How many of these rooms are used for sleeping?
- ☐ Specify: _____rooms
- ☐ Unsure
- ☐ No response

18. OINE BIMWE AHA BINTU EBI NK'EBYAWE AHA BWAWE? *RONDAHO BYOONA*

Does your household own?

EBIRIKUBASIKA.

- ☐ ESIMU Y'OMUNGARO
- ☐ REEDIYO
- ☐ AMASHANYARAZI
- ☐ TINYINE KINTU NA KIMWE AHARI EBYO EBYASHOMWA
- ☐ TARIKUKIHAMYA KURUNGI
- ☐ YAAHUNAMA

Select all that apply.
- ☐ Mobile/cellular telephone
- ☐ Radio
- ☐ Electricity
- ☐ None of the above
- ☐ Unsure
- ☐ No response

19. HARIHO OMUNTU N'OBUYAKUBA OMUNTU OMWE OMUKA EGI OINE EBINTU EBI NK'EBYE AHABWE? *RONDAHO BYOONA EBIRIKUBASIKA.*
    - ☐ EGAARI
    - ☐ PIKIPIKI
    - ☐ EMOTOKA
    - ☐ ENDIIJO NTAMBURA, SHOBORORA: _____
    - ☐ TIHARIHO OINE KIMWE AHIRI EBYO EBYASHOMWA
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

Does any member of your household own? *Select all that apply.*
- ☐ A bicycle
- ☐ A motorcycle or motor scooter
- ☐ A car or truck
- ☐ Other vehicle/mode of transportation (specify): _
- ☐ None of the above
- ☐ Unsure
- ☐ No response

20. OINE AMATUUNGO GOONA, ENYAMAISHWA? YAAGIRA NGU INGAAHA, GYENDA AHA KIBUUZO 26.
    - ☐ EEGO
    - ☐ INGAAHA *[GYENDA AHA KIBUUZO 26]*
    - ☐ TARIKUKIHAMYA KURUNGI *[GYENDA AHA KIBUUZO 26]*
    - ☐ YAAHUNAMA *[GYENDA AHA KIBUUZO 26]*

Does your household currently own any animals? *If no, skip to question 26.*
- ☐ Yes
- ☐ No *[Skip to Q26]*
- ☐ Unsure *[Skip to Q26]*
- ☐ No response *[Skip to Q26]*

21. *YAAGIRA NGU EEGO OMU KIBUUZO 24:* OMUHENDO GW'AMATUNGO GAAWE:
    - ☐ OMUHENDO GW'ENKOKO N'EBINDI BINYONYI _____
    - ☐ OMUHENDO GW'EMPUNU _____
    - ☐ OMUHENDO GW'EMBUZI _____
    - ☐ OMUHENDO GW'ENTE _____
    - ☐ OMUHENDO GW'EMBWA _____
    - ☐ EBINDI, SHOBORORA/ OYOREKYE OMUHENDO: _____
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

If yes to question 24: Please list the number of animals you currently own:
- ☐ Number of Chickens or other birds _____
- ☐ Number of Pigs ____
- ☐ Number of Goats or sheep
- ☐ Number of Cattle ____
- ☐ Number of Dogs ___
- ☐ Other (specify type and number): _____
- ☐ Unsure
- ☐ No response

22. EKA YAAWE EINE ABANYARUGANDA, ABANYWANI, AB'EMIKAGO ABIRI KUKORERA OMU BICWEKA EBINDI NINGA OMU NSI YA HEERU ABARI KUBATWEKYERA ESENTE NINGA EBINTU BUTOOSHA?
    - ☐ EEGO
    - ☐ INGAAHA
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

Does your household have family members or friends working in another town or country who regularly send money or products home to you?
- ☐ *Yes*
- ☐ *No*
- ☐ *Unsure*
- ☐ *No response*

23. OMUNDA Y'ENJU EGI HABEIRE HAFUHIRIRWEMU N'OMUBAZI GW'ENSIRI OMU MYEEZI NKA IKUMI N'EBIRI EHWEIRE? *YAAGIRA NGU INGAAHA, GYENDA AHA KIBUUZO 29.*
    - ☐ EEGO

At any time in the past 12 months, has anyone sprayed the interior walls of your dwelling against mosquitoes? *If no, skip to question 29.*
- ☐ Yes

☐ INGAAHA [*GYENDA AHA KIBUUZO 29]*
☐ TARIKUKIHAMYA KURUNGI *[GYENDA AHA KIBUUZO 29]*
☐ YAAHUNAMA *[GYENDA AHA KIBUUZO 29]*

☐ No *[Skip to Q29]*
☐ Unsure *[Skip to Q29]*
☐ No response *[Skip to Q29]*

24. *YAAGIRA NGU EEGO OMU KIBUUZO 27*, ENJU EFUHIRIRWE, HATI HARABIREHO EMYEEZI ENGAHI?
☐ EMYEEZI ERABIREHO BWANYIMA YAFUHIRIRWA: _____ EMYEEZI
☐ TARIKUKIHAMYA KURUNGI
☐ YAAHUNAMA

If yes to question 27, how many months ago was the house sprayed?
☐ Specify: _____months
☐ Unsure
☐ No response

25. OMU KA EGI, OINEMU OBUTIIMBA BW'ENSIRI OBURI KUBAASA KURARWAMU ABAUNTU? *YAAGIRA NGU INGAAHA, GYENDA AHA KIBUUZO 32.*
☐ EEGO
☐ INGAAHA *[GYENDA AHA KIBUUZO 32]*
☐ TARIKUKIHAMYA KURUNGI *[GYENDA AHA KIBUUZO 32]*
☐ YAAHUNAMA *[GYENDA AHA KIBUUZO 32]*

Does your household have any mosquito nets that can be used while sleeping? *If no, skip to question 32.*
☐ Yes
☐ No *[Skip to Q32]*
☐ Unsure *[Skip to Q32]*
☐ No response *[Skip to Q32]*

26. *YAAGIRA NGU EEGO OMU KIBUUZO 29:* OINEIBUTIIMBA BW'ENSIRI BUNGAHI BWONA HAMWE KANDI OMAZIRE NABWO BWIRECHI? ORIKUBUUZA EBIBUUZO: KYEBERA KANDI AHAMYE EKYO, N'OMUHENDO GWABWE.
☐ OMUHENDO GW'OBUTIIMBA BW'ENSIRI: _____ OBUTIMA BW'ENSIRI
☐ OMAZIRE NABWO BWIRECHI? _____
☐ TARIKUKIHAMYA KURUNGI
☐ YAAHUNAMA

If yes to question 29: How many mosquito nets does your household have and how long have you had them?
Interviewer: Please observe the number of mosquito nets to confirm number.
☐ Specify: ___ mosquito nets
☐ How long have you had them? _____(years)
☐ Unsure
☐ No response

27. *YAAGIRA NGU EEGO OMU KIBUUZO 29: NISHABA KWONGYERA KWETEGYEREZA BIKYE EBIRIKUKWATA AHA BUTIIMBA BW'ENSIRI.* KYEBERA BYONA EBIRI KUKWATWAHO.

If yes to question 29: We would like to know more about each of your mosquito nets. *Select all that apply.*

	OBU WAATUNGA, NINGA OBU WAAGURA AKATIIMBA AKA, KAKABA KARIMU OMUBAZI GW'AKO? *When you got the net, was it already factory treated with an insecticide to kill or repel mosquitoes?*				AKATIIMBA KATEIRWEMU OMUBAZI GWAKO BWANYIMA? *Has the mosquito net been soaked or dipped in a liquid to repel mosquitoes or bugs in the past 12 months?*				AKATIIMBA KAKOZESEIBWE OMU KIRO? *Was the net hanging last night?*			
	EEGO *Yes*	INGAAHA *No*	TARIKUHAMYA *Unsure*	YAAHUNAMA *No response*	EEGO *Yes*	INGAAHA *No*	TARIKUHAMYA *Unsure*	YAAHUNAMA *No response*	EEGO *Yes*	INGAAHA *No*	TARIKUHAMYA *Unsure*	YAAHUNAMA *No response*
AKATIIMBA 1 Net 1	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
AKATIIMBA 2 Net 2	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
AKATIIMBA 3 Net 3	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
AKATIIMBA 4 Net 4	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

AKATII MBA 5 Net 5	☐☐☐☐	☐☐☐☐	☐☐☐☐

28. AMAIZI G'OKUNYWA AHA BW'ABANTU OMU KA EGI NIMUKIRA KUGAIHA/KUGATAHA NKAHI? *ORI KUBUUZA EBIBUUZO: OTASHOMA EBIGARUKWAMU EBI. KURUGIRIRA AHARI EBYO EBI YAAGAMBA, TOORANA ENSHONGA EISHATU OMU BUKURU BWAZO HAZA OZIHANDIIKYE; OTI: HANDIIKA "1" OMWANY A OMUKURU OGURI KWIHWAMU AMAIZI G'OKUNYWA, "2" OMWANYA OGURI KUGARUKA AHA GW'OKUBANZA, "3" OMWANYA GW'AKASHATU GUBE OGWO OGURI KUKOZESEBWA EMYANYA ENKURU YAABA ETARIHO. KOZESA EBY'OKUREEBERAHO BYABA NIBYETAAGISA.*

_____ TAAPU AHEERU Y'ENJU
_____ PAIPU/TAAPU YA BOONA
_____ NAYIKONDO
_____ EIZIBA ERIREEBERIRWE
_____ EIZIBA ERITAREEBERIRWE
_____ OMUDUMO/OMURINDI OGUREEBERIRWE
_____ OMUDUMO/OMURINDI OGUTAREEBERIRWE
_____ KUTANGISIRIZA AMAIZI G'ENJURA
_____ OMUGYERA/ENYANJA/OMURINDI
_____ AMAIZI G'OMU CUPA
_____ EBINDI, SHOBORORA: _____

☐ TARIKUKIHAMYA KURUNGI *[GYENDA AHA KIBUUZO 35]*
☐ YAAHUNAMA *[GYENDA AHA KIBUUZO 35]*

What are the main sources of drinking water for members of your household?
*Interviewer: **Do not** read out options. Based on participant answers, select up to three sources, using numbers to rank importance.*
Private standpipe or outdoor tap, Public standpipe or tap, Tube well or borehole, Dug well (protected), Dug well (unprotected), Water from protected spring, Water from unprotected spring, Rainwater harvesting or cistern, Surface water (river, lake, stream)
Bottled water,
Other (specify): ____
☐ Unsure *[Skip to Q35]*
☐ No response

29. OMUTIINDO GW'AMAIZI GAANYU AG'OKUNYWA NOOGUREEBA OTA?
☐ OMUTIINDO GURI AHANSI MUNONGA
☐ MUBI
☐ HAKIRI
☐ NI MURUNGI
☐ NI MURUNGI MUNONGA
☐ TARIKUKIHAMYA KURUNGI
☐ YAAHUNAMA

How would you rate the overall quality of your drinking water?
☐ Very poor
☐ Poor
☐ Fair
☐ Good
☐ Very good
☐ Unsure
☐ No response

30. NOOSHEMEZA OTA AMAIZI G'OKUNYWA? *TOORANA BYONA EBIRI KUKWATWAHO.*
☐ TINDI KUSHEMEZA MAIZI NA KAKYE
☐ NINGATEEKA
☐ NINGAGYEGYENA
☐ AMAANI G'EIZOOBA N'OMUSHANA
☐ NINKOZESA OMUBAZI NKA "WATER GUARD"
☐ NINGURA AMAIZI AG'OMU CUPA
☐ EBINDI, SHOBORORA: _____
☐ TARIKUKIHAMYA KURUNGI
☐ YAAHUNAMA

Do you treat your drinking water? *Select all that apply.*
☐ Do not treat the water
☐ Boiling
☐ Filtering
☐ Ultraviolet irradiation (i.e. sunlight)
☐ Chemical treatments (e.g. "Water Guard" Tablets)
☐ Purchase purified water
☐ Other (specify): ____
☐ Unsure
☐ No response

31. EKA YAAWE EINE KIGO KI?
ORI KUBUUZA EBIBUUZO: OTASHOMA EBIGARUKWAMU EBI. KYABA NIKYETENGESA, YONGYERA OBUUZE OTI: HARIHO EMYANYA ENDIIJO? KOZESA

What kind of toilet facilities does your household use?

☐ Pit latrine (covered)

EBY'OKUREEBERAHO.

- ☐ EKIHORONI, KYOMBOKIRWE
- ☐ EKIHORONI, KITOMBEKIRWE
- ☐ EKISHAKA
- ☐ EBINDI, SHOBORORA: _____
- ☐ TARIKUKIHAMYA
- ☐ YAAHUNAMA

- ☐ Pit latrine (uncovered)
- ☐ No facilities/ bush/ field
- ☐ Other (specify): ____
- ☐ Unsure
- ☐ No response

32. EKIHORONI/EKIGO N'EKYAWE N'EKA YAAWE MWENKA NINGA NIMUKIKOZESA NA BANDI BANTU?
    - ☐ EKA YANGYE TWENKA
    - ☐ NITUKIKOZESA N'AMAKA MAKYE AGANDI
    - ☐ EKYARO KYOONA
    - ☐ TARIKUKIHAMYA
    - ☐ YAAHUNAMA

Are the toilet facilities you use private, semi-private, or communal?

- ☐ Private
- ☐ Semi-private (shared with a few other households only)
- ☐ Communal
- ☐ Unsure
- ☐ No response

33. AB'OMUKA YAAWE BABEIREHO HAIHI MUNONGA N'ENYAMAISHWA OMU SAANDE NK'IBIRI EZIHINGWIREHO? KWONGYERE KUKYENGYESA ORI KUBUUZIBWA*: OHIKIREHO HAIHI MUNONGA N'ENYAMAISHWA NK'EMBWA N'EZINDI NYAMAISHWA OMU BWIRE OBWO? EMBYZI, ENTE, ENTARMA, ENKOKO, EMPUMU, YAAGIRA NGU INGAAHA, GYENDA AHA KIBUUZO 41.*
    - ☐ EEGO
    - ☐ INGAAHA *[GYENDA AHA KIBUUZO 41]*
    - ☐ TARIKUKIHAMYA KURUNGI *[GYENDA AHA KIBUUZO 41]*
    - ☐ YAAHUNAMA *[GYENDA AHA KIBUUZO 41]*

Have the members of your household been exposed to animals within the last 2 weeks? *Possible clarification: Have you had physical contact or been within one metre of an animal within the last 2 weeks?*

- ☐ Yes
- ☐ No *[Skip to Q41]*
- ☐ Unsure *[Skip to Q41]*
- ☐ No response *[Skip to Q41]*

34. *YAAGIRA NGU EEGO OMU KIBUUZO 37:* TOORANA ZOONA EZIRIKUKWATWAHO. *RONDAHO BYOONA EBIRIKUBASIKA.*
    - ☐ EMPUNU Z'OMUKA
    - ☐ ENTE
    - ☐ EMBWA
    - ☐ ENYONYI Z'OMUKA (i.e. NK'ENKOKO)
    - ☐ EMBUZI/ENTAAMA
    - ☐ ENYAMAISHWA EZINDI (SHOBORORA): _____
    - ☐ ENKIMA/ENKYENDE
    - ☐ EMBEBA
    - ☐ ENYAMAISHWA EZINDI EZ'OMUKISHAKA: _____
    - ☐ TARIKUKIHAMYA
    - ☐ YAAHAUNAMA

If yes to question 37: What animals was your household exposed to? *Select all that apply.*

- ☐ Domestic pigs
- ☐ Domestic cattle
- ☐ Dogs (domestic or feral)
- ☐ Domestic birds (i.e. chickens)
- ☐ Goats or sheep
- ☐ Other domestic animal (specify): _____
- ☐ Monkeys
- ☐ Rodents
- ☐ Other wildlife (specify): _____
- ☐ Unsure
- ☐ No response

35. *YAAGIRA NGU EEGO OMU KIBUUZO 37: HARIHO OBU ENYAMAISHWA ZAAWE ZIRIKUTAAHA OMU NJU?*
    - ☐ EEGO
    - ☐ INGAAHA
    - ☐ TARIKUKIHAMYA
    - ☐ YAAHUNAMA

If yes to question 37: Do your animals ever come inside your house?

- ☐ Yes
- ☐ No
- ☐ Unsure
- ☐ No response

36. *YAAGIRA NGU EEGO OMU KIBUUZO 37:* ENYAMAISHWA ZEINE ENJU YAAZO HANGAHARI/ ZONKA?
- ☐ EEGO
- ☐ INGAAHA
- ☐ TARIKUKIHAMYA
- ☐ YAAHUNAMA

If yes to question 37: Do you have a separate shelter for your animals?
- ☐ Yes
- ☐ No
- ☐ Unsure
- ☐ No response

37. NITWENDA KUMANYA AB'OMUKA YAAWE BAABA NIBEEJUMBA OMU MIRIMO ERI KURUGA AHA MIRUNDI ESHATU OMU SAANDE N'OKUKIRAHO? *TOORANA BYONA EBIRI KUKWATWAHO.*

We are interested in whether any members of your household participate in the following activities 3 or more times a week, and for what purpose? *Select all that apply.*

	TIBARI KWEJUMBAMU	KURONDA EBY'OKURYA	KURONDA EKY'OKUTUNDAMU SENTE	KURONDA EKY'OKUHANISAMU EBINTU EBI NTAINE KURUGA OMU BANDI	KURONDAMU EMIBAZI Y'OKURAGURA	EBINDI, SHOBORORA	TARIKUKI HAMYA	YAAHUNAMA
	Do not participate in this activity	*To provide food for my family*	*To sell for income*	*To give as gifts or non-monetary trading with family or friends*	*For spiritual or medicinal purposes*	*Other (specify):*	*Unsure*	*No response*
KUSHOHA EBY'ENYANJA Fishing	☐	☐	☐	☐	☐		☐	☐
KUHINGA Agriculture - tilling land/ agrolabour	☐	☐	☐	☐	☐		☐	☐
KURIISA Agriculture - tending animals	☐	☐	☐	☐	☐		☐	☐
KUKORA OMU MISIRI Agriculture - tending crops	☐	☐	☐	☐	☐		☐	☐
KUHIGA Hunting	☐	☐	☐	☐	☐		☐	☐
KUCWA EMIBAZI	☐	☐	☐	☐	☐		☐	☐

Collection of medicinal plants								

EKYI NIKYO KIBUUZO KYAHA MUHERU ***That was my last question***

38. OINE EKINDI KIBUUZO EKI ORIKWENDA KUMBUUZA NINGA EKINDI KINTU EKI ORI KWENDA KUNSHOBORE RAHO? *ORI KUBUUZA EBIBUUZO? HANDIIKA EBYO BYONKA EBI EBIRI KUKWATA AHA NSHONGA EZI.*

Do you have any other questions or comments? *Interviewer: type any additional comments the respondent has said that are relevant*

SHOBORORA:

Comments:

_____

_____

_____

YEBARE MUNONGA. EBIGARUKWAMU EBI WAAHAYO NIBAIJA KUTEERANWA N'EBYA BANDI BANTU ABAABUZIBWA OMU KUCOONDOOZA OKU. BWANYIMA HARUGYEMU AMAKURU AHA MAGARA GA BANTU OMU KICWEKA EKI. EBYO EBIRAYEGWE AHA MAGARA GA BANTU, NIBIIJA KUGUMA BIRI EBYEKIHAMA KANDI TIHARIHO EIZIINA RY'OMUNTU N'OMWE ERIRAMANYWE ABANDI BANTU NINGA GAVUMENTI. YEBARA MUNONGA KUKWATANISA NAITWE.

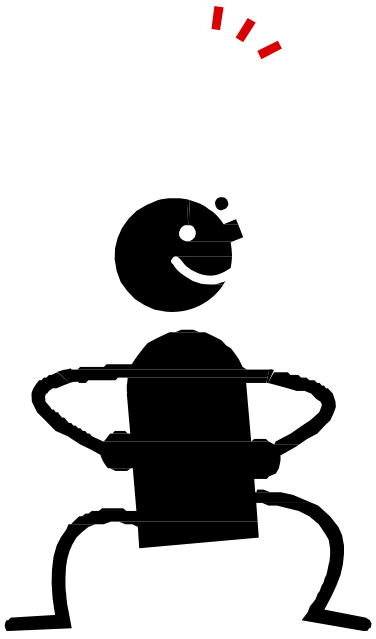
With all other participants to give us information about the health of people throughout the community. The information you provided is strictly confidential and no names will be released to the community or government. Thank you again for your time and cooperation.

39. EKIGAANIIRO KYAHWA SHHAHA: _____ Time finished: _____

IHACC

EBIBUUZO: BY' OMUNTU AH'ABWE | INDIVIDUAL QUESTIONNAIRE .

EKICWEKA A: EBIRI KUKWATA AHA KICWEKA/EKYARO/OMUNTU OGW' ORIKUBUUZIBWA	EBIBUUZO ABIRI NA BINA	**PART A:** Demographics	16 questions
EKICWEKA B: EBY'AMAGARA	EBIBUUZO BIRI	**PART B:** Clinical evaluation	3 questions
EKICWEKA C: EBIRI KUREETAHO ENDWARA	EBIBUUZO MWENDA	**PART C:** Risk factors	8 questions
EKICWEKA E: ENDWARA Z'OKUTANAKA, N'OKWIRUKANA, NA EZAMAANI	EBIBUUZO IKUMI MWENDA	**PART E:** Acute gastrointestinal illness	19 questions
EKICWEKA F: EBIRI KUKWATA AHA MUSHWEIJA	EBIBUUZO MWENDA	**PART F:** Self-reported fever	14 questions
EBIBUUZO EBIRI KUHENDERA EKIGAANIIRO	EBIBUUZO BIBIRI	**Completion questions**	1 question
EBIBUUZO BYOONA HAMWE:	**EBIBUUZO NKAAGA NA BITAANO**	**Total:**	**61 questions**



INFORMED CONSENT

1. **EBIBUZO EBITURIKUZA KUBUUZA NIBITWARA NK'EDAKIKA 20**
   This questionnaire will take about 20 minutes to complete.

2. **NOBASA KWIKIRIZA KUBUZIBWA, KANDI NOBASA KURUGAMU WABA NOYENDA.**
   You can choose not to participate, or to withdraw at any time without a problem.

3. **WABA OTAKWENDA KUGARUKAMU EKIBUZO KYONA, NOBASA KUKIREKA NITUUZA AHA KIRIKUKURATAHO**
   If you do not want to answer a question, you do not have to and we will move on to the next one.

4. **NITUKWAKIRA KUGABANA AHA BYOKURYA EBITWARETA N'OBUWAKUBA OTABBUZIBWE EBIBIBUZO.**
   You are welcome to share in the food we bring whether you participate or not.

5. **EBIRARUGYE OMUKUCONDOOZA OKU NIBYIJA KUYAMBA OMUBY'ENTUNGUKA Y'EKYARO KYANYU N'EBINDI BICWEKA.**
   This research will be shared with other people and the information can be used to help other communities like yours in other places.

6. **OINE EKIBUZO KYOONA TUTAKATANDIKIRE?**
   Do you have any questions before we begin?

7. **KU ORABE OINE EKIBUZO KYONA NOBASA KUBUZA:**
   If you have questions later about the project, contact:

   Dr. Shuaib Lwasa: 256 772 461727
   Mr. Didas Namanya: 256 772 484771

ORIKUBUUZIBWA YAAHA ORUSA:

- ☐ EEGO
- ☐ INGAAHA

Informed consent:

- ☐ Respondent agrees to be interviewed
- ☐ Respondent does not agree to be interviewed

EKICWEKA A - EBIRIKUKWATA AHA KICWEKA/EKYARO/OMUNTU OGW'ORIKUBUUZIBWA

PART A – Demographics

1. EKICWEKA (*EKYARO/LC*): _____
2. EBIRO BY'OKWEEZI: _____ (dd; mm; yr)
3. EIZIINA RY'ORI KUBUUZA EBIBUUZO: _____
4. EIZIINA RY'ORIKUBUUZIBWA *(AHA KUHANDIIKWA HONKA)*:
_____
5. AKAMANYISO K'OMUNTU ORIKUBUUZIBWA *(AKAMANYISO K'OMUNTU AHA KUHANDIIKWA HONKA)*: _____
6. AKAMANYISO KEEKA *(AKAMANYISO KAMAKA AHA KUHANDIIKWA HONKA)*:
_____
7. YOREKA KU AKAMANYISO K'OMUNTU ORIKUBUUZIBWA AKASYA KAHANDIKIRWE
   - ☐ EEGO
   - ☐ INGAAHA
   - ☐ AKAMANYISO KAYIKIRIZIBWA MUKURUWABACOONDOZI: _____
8. OBUHANGWA BW'OMUNTU *(AHA KUHANDIIKWA HONKA)*:
   - ☐ MUSHAIJA
   - ☐ MUKAZI
9. ORIKUBUZIBWA NAMANYA EMYAKA YE?
   - ☐ EEGO
   - ☐ INGAAHA
10. OINE EMYAKA ENGAHI? _____

*TEBEREZA EMYAKA **EKI KIKORWE HONKA YABA ATARIKUMANYA EMYAKA YE**:*

- ☐ AHANNSI Y'OMWAKA GUMWE
- ☐ OMWAKA GUMWE KUHIKA AHA MYAKA ETAANO
- ☐ EMYAKA MUKAAGA KUHIKA AHA MYAKA IKUMI N'EBIRI
- ☐ EMYAKA IKUMI N'ESHATU KUHIKA AHA MYAKA ABIRI N'ESHATU
- ☐ EMYAKA ABIRI N'ENA KUHIKA AHA MYAKA ASHATU N'ETAANO
- ☐ EMYAKA ASHATU NA MUKAAGA KUHIKA AHA MYAKA ANA NA MUSHANJU
- ☐ EMYAKA ANA NA MUNAANA KUHIKA AHA MYAKA ATAANO NA MWENDA
- ☐ EMYAKA NKAAGA, NINGA AHAIGURU
- ☐ INGAAHA

Location (i.e. village):_____

Today's Date:_____(dd; mm; yr)

Interviewer name: _____

Participant name*)*:
_____

Individual ID:
_____

Household ID:
_____

Indicate if a new code was generated for this participant
☐ Yes
☐ No
Code approved: _____

Sex:
☐ Male
☐ Female

Does this participant know his/her age?

☐ Yes

☐ No

Age: _____

Estimate age range (only if unknown
☐ < 1 year
☐ 1-5 years
☐ 6-12 years
☐ 13-23 years
☐ 24-35 years
☐ 36-47 years
☐ 48-59 years
☐ ≥60 years
☐ No response

11. EBY'OBWEGYESE: RONDAHO AHARI EBI EKIRIKWIRIRIRA OBWEGYESE BWAWE?
    - ☐ TINKAZAGA MU ISHOMERO, TINDIKUBAASA KUHANDIIKA NINGA KUSHOMA
    - ☐ TINKAZAGA MU ISHOMERO, NIMBAASA KUHANDIIKA N'OKUSHOMA
    - ☐ NKASHOMA PURAYIMARY NAGIMAARA
    - ☐ NKAMARA PURAYIMARE
    - ☐ NKAMARA SINIYA YAKANA
    - ☐ ITENDEKYERO BWANYIMA YA SINIYA
    - ☐ TARI KUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

What is the highest education you have attained?
☐ No formal schooling (cannot read or write)
☐ No formal schooling (can read or write)
☐ Primary incomplete
☐ Primary complete
☐ Secondary complete
☐ Higher education of any form
☐ Unsure
☐ No response

12. *ABO BOONA ABIANE OBWEGYESE AHIAGURU* OMU ISHOMERO OKAMARA MU EMYAKA ENGAHI? *(AHA KUHANDIIKWA HONKA)*
    - ☐ EMYAKA YENYINI:_____
    - ☐ TARI KUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

How many years of formal schooling do you have in total?
☐ Specify: _____years
☐ Unsure
☐ No response

13. OINE OMURIMO OGURI KUKUHA ENTAASYA EBIRO EBI? INGAAHA, GYENDA AHA KIBUUZO 17. TICK 'YAAHUNAMA" FOR INFANTS AND YOUNG CHILDREN.
    - ☐ EEGO: NINTUNGA OMUSHAARA, RIJARIJA
    - ☐ EEGO: NINYEKOZESA
    - ☐ EEGO: KWONKA TINYINE NTAASYA
    - ☐ INGAAHA *[GYENDA AHA KIBUUZO 17]*
    - ☐ TARI KUKIHAMYA KURUNGI *[GYENDA AHA KIBUUZO 17]*
    - ☐ YAAHUNAMA *[GYENDA AHA KIBUUZO 17]*

Are you currently employed? *If no, skip to Question 17.* Tick 'No response" for infants and young children.

☐ Yes: Paid employment
☐ Yes: Self-employment
☐ Yes: Non-paid employment
☐ No
☐ Unsure
☐ No response

14. *YAABA NATUNGA OMUSHAARA, NINGA RIJARIJA OMU KIBUUZO 13,* NIMURIMO KI OGWORIKUKORA?
    - ☐ OBWIRE BWONA
    - ☐ NINKORA RIMWE NA RIMWE, BUTOOSHA
    - ☐ NINKORA OMU SIZOONI EMIRIMO YAAREEBEKA
    - ☐ OBU NAGUBONA BWONKA; NOKURONDARONDA
    - ☐ TARI KUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

If yes to above question: In what capacity are you currently employed?
☐ *Full-time employment*
☐ *Part-time stable employment*
☐ *Seasonal employment*
☐ *Ad-hoc or odd-jobs*
☐ *Unsure*
☐ *No response*

15. *YAABA NATUNGA OMUSHAARA, NINGA RIJARIJA OMU KIBUUZO 13:* OMURIMO GWAAWE GWENYINI NI GUHA?
    - ☐ EKYO EKI ARIKUKORA/OMURIMO GWENYINI: _____
    - ☐ TARI KUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

If yes to above question: What is your main occupation?
☐ Specify: _____
☐ Unsure
☐ No response

16. *YAABA NATUNGA OMUSHAARA, NINGA RIJARIJA OMU KIBUUZO 13*: NI MIRIMO KI ENDIIJO ERIKUKUTAAHIZA AKASENTE?
    - ☐ EKYO KYENYINI EKI ARIKUKORA: _____
    - ☐ TAINE MIRIMO ENDIIJO
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

If yes to above question: What are your secondary occupations?
☐ Specify: _____
☐ No secondary occupations
☐ Unsure
☐ No response

EKICWEKA B - OKUCOONDOZA AHA BY'AMAGARA

PART B Clinical evaluation

17. OINE ENDWARA YOONA EY'ORUBEERERA? *(NKA TB/KAKONKO; OMUTIMA, SHUKAARI)*
    - ☐ EEGO/ NDWARA KI YENYINI: _____
    - ☐ INGAAHA
    - ☐ TARIKUKIHAMYA KURUNGI
    - ☐ YAAHUNAMA

Do you have any chronic pre-existing medical conditions? (TB, heart disease, respiratory disease, diabetes)
- ☐ Yes (specify): _____
- ☐ No
- ☐ Unsure
- ☐ No response

18. WAAHURIRA KUBI OMU MAGARA, NINGA WAARWARA, NOOKIRA KWERAGURIRA OTA? *TOORANAHO EBIGARUKWAMU BYOONA EBIRIKUBAASIKA.*
- ☐ NINKOZESA EMIBAZI Y'EKISHAKA HAIHI N'EKA, KURUGA OMU BISHAKA BYA HAIHI
- ☐ NINZA KW'EBUUZA AHA MUSHAHO W'EKIIRAGUJU
- ☐ NINZA OMU IRWAARIRO ERINDI HAIHI
- ☐ NINGURA OMUBAZI AHA DUUKA
- ☐ TINYINE EKI NDIKUKORA
- ☐ HAABA HARIHO EKINDI EKI ORI KUKORA WAAHURIRA WAARWARA, NI KI: _____
- ☐ TARIKUKIHAMYA KURUNGI
- ☐ YAAHUNAMA

When you feel sick, how do you regularly treat ailments? *Select all that apply*
- ☐ Use traditional herbs or medicines grown around house or nearby
- ☐ Consult a traditional medical practitioner
- ☐ Visit local hospital or nearest health centre
- ☐ Take over-the-counter medication
- ☐ Do nothing
- ☐ Other (specify): _____
- ☐ Unsure
- ☐ No Response

19. NOOKIRA KWEJUMBA OMU KUKORA EBINTU EBI KUHINGUZA OMURUNDI GUMWE OMU KWEEZI? *TOORANA BYOONA EBIRI KUKUKWATAHO.*
- ☐ KUNYWA AMAARWA
- ☐ KUREESA SIGARA
- ☐ KUKOZESA EMIBAZI EY'EKITOKOZA BWONKO
- ☐ TARIKUKIHAMYA KURUNGI
- ☐ YAAHUNAMA

Do you generally participate in any of the following activities more than once a month? *Select all that apply.*
- ☐ Drink alcohol
- ☐ Smoke cigarettes
- ☐ Use recreational drugs
- ☐ Unsure
- ☐ No response

Appendix II - Batwa Community Characteristics Survey

Design by: Blanaid Donelly, Kaitlin Patterson, Fortunate Twebaze & Sierra Clark

The following questions aim to capture general characteristics of a selection of cells within Kanungu District. For each question, please circle one option for each Cell.

1. Please rate each of the following Cells with regards to terrain type.

Cell	Terrain type	Comments
Mukongoro	Mountainous/Flat/Mixed	
Kitariro	Mountainous/Flat/Mixed	
Bikuuto	Mountainous/Flat/Mixed	
Buhoma	Mountainous/Flat/Mixed	
Kebiremu	Mountainous/Flat/Mixed	
Kikome/Kitahurira	Mountainous/Flat/Mixed	
Byumba	Mountainous/Flat/Mixed	
Kishanda	Mountainous/Flat/Mixed	
Kihembe	Mountainous/Flat/Mixed	
Mukono	Mountainous/Flat/Mixed	

2. Please rate each of the following cells with regards to the frequency of crop raiding by wildlife.

Cell	Crop raiding by wildlife	Comments
Mukongoro	Often/Sometimes/Never	
Kitariro	Often/Sometimes/Never	
Bikuuto	Often/Sometimes/Never	
Buhoma	Often/Sometimes/Never	
Kebiremu	Often/Sometimes/Never	
Kikome/Kitahurira	Often/Sometimes/Never	
Byumba	Often/Sometimes/Never	
Kishanda	Often/Sometimes/Never	
Kihembe	Often/Sometimes/Never	
Mukono	Often/Sometimes/Never	

3. Please rate each of the following cells with regards to the ease of road access. Please consider both road quality and type.

Cell	Ease of road access	Comments
Mukongoro	Good/Fair/Poor	
Kitariro	Good/Fair/Poor	
Bikuuto	Good/Fair/Poor	
Buhoma	Good/Fair/Poor	
Kebiremu	Good/Fair/Poor	
Kikome/Kitahurira	Good/Fair/Poor	
Byumba	Good/Fair/Poor	
Kishanda	Good/Fair/Poor	
Kihembe	Good/Fair/Poor	
Mukono	Good/Fair/Poor	

4. Please rate each of the Cells with regards to access to markets.

Cell	Access to small market/shops	Access to large market	Comments
Mukongoro	Good/Fair/Poor	Good/Fair/Poor	
Kitariro	Good/Fair/Poor	Good/Fair/Poor	
Bikuuto	Good/Fair/Poor	Good/Fair/Poor	
Buhoma	Good/Fair/Poor	Good/Fair/Poor	
Kebiremu	Good/Fair/Poor	Good/Fair/Poor	
Kikome/Kitahurira	Good/Fair/Poor	Good/Fair/Poor	
Byumba	Good/Fair/Poor	Good/Fair/Poor	
Kishanda	Good/Fair/Poor	Good/Fair/Poor	
Kihembe	Good/Fair/Poor	Good/Fair/Poor	
Mukono	Good/Fair/Poor	Good/Fair/Poor	

Additional comments:

Appendix III - Batwa Household Demographics

Independent Variable Name	Total number of responses (%)	mean	Mean FS (CI)	Coefficient (Confidence Interval)	SE	P-value
Household Level Variables						
Sex of Food Security respondent	764	-	-	-	-	-
Male	98 (13)	-	14.01 (12.89-15.13)	0.10 (-1.11-1.32)	0.62	0.863
Female	666 (87)	-	14.27 (13.68-14.87)	ref	ref	ref
Sex of Head of Household	565	-	-	-	-	-
Male	412 (73)	-	14.37 (13.59-15.15)	0.00 (-1.38-1.38)	0.70	1
Female	153 (27)	-	14.41 (13.34-15.48)	ref	ref	ref
Highest level of Adult female education	767	-	-			
No formal schooling	467 (61)	-	14.73(14.04-15.41)	ref	ref	ref
Primary incomplete	244 (32)	-	13.67(12.81-14.52)	0.86 (-1.83-0.10)	0.49	0.08
Primary complete or Above	56 (7)	-	12.64 (10.60-14.68)	-1.72 (-3.51-0.07)	-1.72	0.06
Number of Household members employed	767	0.724	-	-0.11 (-0.62-0.39)	0.26	0.665
Any member of household diagnosed with chronic disease	767	-	-			
Yes	258 (34)	-	14.86 (13.29-14.58)	0.81 (-0.07-1.70)	0.45	0.071
No	509 (66)	-	13.94(14.01-15.71)	ref	ref	ref
Any member of household drink alcohol?	767	-	-			
Yes	548 (71)	-	14.44 (12.69-14.81)	0.59 (-0.43-1.62)	0.52	0.258
No	219 (29)	-	13.75 (13.83-15.05)	ref	ref	ref
Number of dependents	751	2.63	-	0.49 (0.26-0.73)	0.12	0.000
How many people sleep in each room	763	2.72	-	0.45 (0.11-0.80)	0.17	0.009
Wealth Variables						
Does your household have handwashing facilities nearby?	765	-	-			
Yes	256 (33)	-	12.85 (12.01-13.69)	-1.80 (-2.66-0.93)	0.44	0
No	509 (67)	-	14.95 (14.36-15.55)	ref	ref	ref
Does your family have soap?	763	-	-			
Yes	171 (22)	-	12.10 (11.10-13.10)	-2.24 (-3.23-1.26)	0.50	0
No	592 (78)	-	14.86 (14.30-15.42)	ref	ref	ref
What type of fuel does your household use?	767	-	-			
Firewood	756 (99)	-	14.28 (8.18-15.81)	2.01 (-2.66-6.69)	2.38	0.399
Charcoal	11 (1)	-	12 (13.72-14.83)	ref	ref	ref
Is your toilet private?	765	-	-			
Private single family usage	496 (65)	-	14.15 (13.52-14.79)	ref	ref	ref
Semi-private, a few families share	229 (30)	-	14.31 (13.44-15.17)	0.10 (-0.77-0.98)	0.44	0.814
Communal	40 (5)	-	15.07 (12.98-17.17)	1.33 (-0.53-3.21)	0.95	0.161

Does your family own land?	752	-	-			
Yes	577 (77)	-	14.48 (13.82-15.13)	0.96 (-0.03-1.97)	0.51	0.058
No	175 (23)	-	13.74 (12.84-14.65)	ref	ref	ref
Does your family own animals?	765	-	-			
Yes	206 (27)	-	14.08 (13.07-15.08)	0.35 (-0.63-1.33)	0.50	0.483
No	559 (73)	-	14.31 (13.68-14.95)	ref	ref	ref
Does your family own chickens?	767	-	-			
Yes	96 (13)	-	13.35 (11.82-14.88)	-0.66 (-1.95-0.62)	0.65	0.311
No	671 (87)	-	14.37 (13.81-14.94)	ref	ref	ref
Does your family own Pigs?	767	-	-			
Yes	68 (9)	-	13.12 (11.63-14.61)	-1.13 (-2.63-0.35)	0.76	0.137
No	699 (91)	-	14.35 (13.78-14.93)	ref	ref	ref
Does your family own goats?	767	-	-			
Yes	102 (13)	-	14.31 (12.78-15.85)	0.68 (-0.62-1.99)	0.66	0.306
No	665 (87)	-	14.23 (13.65-14.82)	ref	ref	ref
Does your family own cattle?	767	-	-			
Yes	4 (1)	-	14.23 (13.68-14.79)	1.05 (-4.35-6.44)	2.74	0.7
No	763 (99)	-	16.5 (13.03-19.96)	ref	ref	ref
Does your family own rabbits?	767	-	-			
Yes	26 (3)	-	14.18 (13.62-14.75)	1.67 (-0.75- 4.10)	1.23	0.177
No	741 (97)	-	15.97 (14.35-17.59)	ref	ref	ref
Does your family own a phone?	767	-	-			
Yes	87 (11)	-	14.16 (12.86-15.45)	-0.04 (-1.39-1.31)	0.68	0.953
No	680 (89)	-	14.26 (13.67-14.84)	ref	ref	ref
Does your family own a radio?	767	-	-			
Yes	288 (38)	-	14.28 (13.66-14.90)	-0.06 (-0.92-0.79)	0.43	0.885
No	479 (62)	-	14.18 (13.33-15.04)	ref	ref	ref
Does your family receive remmittances?	765	-	-			
Yes	74 (10)	-	14.01 (12.73-15.30)	-0.38 (-1.75-0.98)	0.69	0.584
No	691 (90)	-	14.27 (13.69-14.86)	ref	ref	ref
Community Level Variables						
Landscape	767	-	-			
Flat	76 (10)	-	13.32 (11.95-14.70)	ref	ref	ref
Mixed	419 (55)	-	13.85 (13.11-14.59)	0.77 (-0.93-2.48)	0.87	0.375
Hilly	272 (35)	-	15.11 (14.31-15.91)	1.57 (-0.13-3.29)	0.87	0.072
Access to Small Markets	767	-	-			
Good	277 (36)	-	14.32 (13.45-15.20)	ref	ref	ref
Fair	403 (53)	-	13.92 (13.22-14.62)	-0.39 (-1.36-0.57)	0.49	0.427
Poor	87 (11)	-	15.49 (13.82-17.16)	0.75 (-0.90-2.41)	0.84	0.372
Access to Large Markets	767	-	-			

	Good	403 (53)	-	14.42 (13.66-15.17)	ref	ref	ref
	Fair	323 (42)	-	14.16 (13.38-14.94)	-0.17 (-1.16-0.81)	0.50	0.729
	Poor	41 (5)	-	13.24 (11.38-15.10)	-1.49 (-3.72-0.73)	1.13	0.188
Road Access		767	-	-			
	Good	105 (14)	-	13.39 (11.72-15.06)	ref	ref	ref
	Fair	608 (79)	-	14.57 (13.99-15.15)	0.99 (-0.45-2.43)	0.73	0.177
	Poor	54 (7)	-	12.22 (10.39-14.04)	-1.20 (-3.54-1.13)	1.19	0.313
Crop Raiding		767	-	-			
	Often	132 (17)	-	13.37 (12.37-14.38)	ref	ref	ref
	Sometimes	91 (12)	-	15.08 (13.39-16.77)	1.10 (-0.77-2.98)	0.95	0.248
	Never	544 (71)	-	14.32 (13.67-14.96)	0.56 (-0.73-1.87)	0.66	0.396
Quality of Land		767	-	-			
	Good	224 (29)	-	14.48 (13.32-15.63)	ref	ref	ref
	Fair	161 (21)	-	14.04 (12.75-15.33)	-0.61 (-2.16-0.94)	0.79	0.442
	Poor	382 (50)	-	14.18 (13.50-14.87)	-0.34 (-1.61-8.91)	0.64	0.59

Appendix IV – Univariate results

Table: Results of the unconditional univariate linear regression models, using a random intercept to control for repeated household measurements for predictors of food insecurity among the Batwa Pygmies of Kanungu District, Uganda, October 2012-April 2014

Independent Variable Name	Total (%)	Mean	Mean FS (CI)	Coefficient (CI)	Household clustering p-value
Highest adult female education	767				0.00
No formal schooling	467(61)		14.84 (14.71-15.51)	Ref.	Ref.
Primary incomplete	244(32)		13.77 (12.93-14.61)	-0.86 (-1.83-0.10)*	
Primary complete or Above	56(7)		12.94 (10.85-15.04)	-1.54 (-3.31- 0.22)*	
Presence of chronic disease	767				0.00
Yes	258 (34)		14.98 (14.14-15.83)	0.82 (-0.05-1.70)*	
No	509 (66)		14.05 (13.42-14.68)	Ref.	Ref.
N. people	764	4.78		0.36 (0.16-0.56)***	0.00
N. dependents	751	2.63		0.47 (0.24-0.70)***	
N. of rooms used for sleeping	763	1.83		0.75 (0.07-1.42)**	0.00
N. of people sleeping/room	763	2.72		0.39 (0.05- 0.72)**	0.00
Wealth Quantiles	767				0.00
Poorest	201 (26)		15.08 (14.16-15.99)	Ref.	Ref.
Very poor	302 (39)		15.03 (14.33-15.73)	0.00 (-1.00-1.02)	
Poor	74 (10)		12.30 (10.92-13.69)	-2.44 (-3.92--0.96)***	
Least poor	190 (25)		13.35 (12.43-14.26)	-1.44 (-2.58- -0.31)**	

Table: Results of the univariate linear regression models, using a random intercept to control for community-level clustering for predictors of Food security among the Batwa Pygmies of Kanungu District, Uganda, October 2012-April 2014

Independent Variable Name	Total (%)	Mean FS (CI)	Coefficient (CI)	Standard error	Community clustering p-value
Type of landscape	767				0.0015
Hilly	151 (20)	15.10 (13.84-16.36)	Ref.	Ref.	
Mixed	407 (53)	14.18 (13.51-14.85)	-0.65 (-2.50-1.19)	0.94	
Flat	209 (27)	14.81 (13.00-15.35)	-0.66 (-2.84-1.50)	1.11	
Access to small markets	767				0.0099
Good	310 (40)	13.99 (13.14-14.84)	Ref.	Ref.	
Fair	357 (47)	14.26 (13.50-15.03)	-0.14 (-1.54-1.26)	0.71	
Poor	100 (13)	15.87 (14.32-17.42)	1.65 (-0.53-3.83)	1.11	
Access to major trading center	767				0.0031
Good	302 (39)	14.67 (13.76-15.59)	Ref.	Ref.	
Fair	100 (13)	12.94 (11.68-14.21)	-1.83 (-3.72-0.05)*	0.96*	
Poor	365 (48)	14.49 (13.74-15.25)	-0.36 (-1.79-1.07)	0.73	
Access to markets	767				0.0878
Good	93 (12)	15.78 (14.64-16.94)	Ref.	Ref.	
Fair	419 (55)	13.63 (12.89-14.36)	-2.20 (-3.80- -0.60)***	0.81***	

Poor	255 (33)	15.05 (14.16-15.95)	-0.82 (-2.52-0.88)	0.86	
Experiences with crop raiding	767				0.0096
Often	461 (60)	14.66 (13.91-15.41)	Ref.	Ref.	
Sometimes	104 (14)	14.99 (13.77-16.21)	0.32 (-1.72-2.35)	1.04	
Never	202 (26)	13.35 (12.49-14.22)	-1.27 (-2.73-0.18)*	0.74*	
Land Quality	767				0.0004
Good	217 (28)	14.53 (13.48-15.57)	Ref.	Ref.	
Fair	209 (27)	14.18 (13-15.35)	-0.18 (-2.18-1.82)	1.02	
Poor	341 (44)	14.37 (13.65-15.10)	0.01 (-1.68-1.71)	0.86	

CI, confidence interval
Coefficients and P-values generated from univariate linear models
*0.10 ** 0.05 ***0.01

Appendix V - Batwa focus group discussion guide

Instructions for interviewers:

- This interview is part of the Indigenous Health Adaptations to Climate Change research
- This interview is not affiliated with the Batwa Development program, or Bwindi community hospital or any other organization, even though IHACC works in partnership with those organizations
- IHACC is not an NGO, and will not bring any immediate benefits
- IHACC's research ill assist in long-term knowledge around indigenous health and climate change, in particular food security intervention strategies for the future
- This group activity is discussion based, we want to hear your personal opinion and ideas around a topic and your responses will remain confidential
- You can back out of the discussion at any time and you will still be able to partake in the community lunch.
- These questions are not yes or no questions, we want to hear your ideas, experience and beliefs surrounding questions

Section	Questions	Follow-ups
Actual Question: Tell me about how you get food and what you eat? **Ekibuuzo kyenyine: ngambira ok'worikutunga ebyokurya hamwe nekyorikurya?**		
Access	What is the primary way your family acquires food? **Nimuringo ki ogu eka yawe erikutungamu ebyokurya?**	Are there any other ways your household acquires food **Hariho emiringo endijo eyi eka yawe erikutungiramu ebyokurya?**
	If you buy food where do you buy it from? From who? How expensive is it? **Kumurabe nimugura ebyokurya, nimubigura nkahe? ahari baaha? kandi nibabiguza bata?**	
	How often does your household acquire food? **Eka yawe burijo netunga nka ryari ebyokurya?**	Daily, weekly, monthly? **Burizooba, buriwiki, burimwezi?**
	Who is responsible for getting food for the household? **Noha oyine obujunanizibwa bwokubaha ebyokurya omuka omuka egi?**	
	Does anyone or organization help your household acquire food? **Hariho omuntu wena ninga ekitongole ekirikubayamba kutunga ebyokurya omurye**	

	'gika?	
	What are the biggest barriers to accessing food? **Ni bintu ki ebirikusingayo kubateganisa omu kutunga ebyokurya?**	Money? Lack of land? Lack of social networks? **Esente? Okubura eitaka? Okubura emikago?**
Actual Question: Are some families more food secure than others? Why? **Ekibuuzo kyenyine: hariho eka eziri gye omukintu kyebyokurya kusinga ezindi? Ahabwenkyi**		
Comprehension and Perception **Entekyereza**	What do you think food security is? **Notekyereza ngu ebyokurya byokwerindisa nikyimanyisa kyi?**	
	Do you think food security is a problem? **Notekyereza ngu okwerindasa ebyokurya nekizibu?**	Why? **Ahabyenki?**
	Is having enough food one of your biggest concerns? **Hoona okuba nebyokurya birikumara nikimwe ahabintu byorikufaho munoonga?**	If not what is? **Kyaba kitari ekyo reero niki?**
	Are there other households that are more secure than you? **Hariho amaka agandi agarigye okubasinga?**	In what way? Why do you think that is? **Mu muringo ki?** **Nahabwenki orikutekyereza otyo?**
	Does food security vary within this village? **Hoona okwerinda kwebyokurya nikuhindahinduka omuri'ekikyaro?**	What way and why? **Muringo ki kandi ahabwenki?**
	Does food security vary between this community and others? **Okwerindisa ebyokurya nikuhindahindika omuri ekyikyaro hamwe nebindi byaro?**	What way? Why? **Muringo ki kandi ahabwenki?**
Actual Question: Is there more food at sometimes than others? Why? **Ekibuzo kyenyine: hariho abeine ebyokurya bingi kusiinga abandi? Ahabwenki?**		
Coping and Adaptation **Okurebera ahabandi ninga ebindi hamwe nokwikyiriza embera**	What do you do when you run out of food? **Nokora ki ebyokurya byaheza kubura ninga kukuwhaho?**	

	Do you have to reduce other spending? **Noba oyine kukyendeza aha sente zorikukozesa/kushohoza ahabindi intu?**	
	Are there ways to acquire food if you have no money? **Hariho emiringo yorikubona mu ebyokurya waba oyine esente?**	Do you have other families that will help? What can you trade to get food? **Oyine agandi maka agarikubaasa kukuyamba? Nobaasa kuguza ki kutunga ebyokurya?**
	What have you done in the past? **Otwiire nokora ki kuruga enyima?**	
Health outcomes **Ebyamagara**	What are the negative impacts of not having enough food? **Nibizibu ki ebirikubaho waba otine ebyokurya birikumara?**	What ways have you been impacted? What about your children? **Ni miringo ki eyotungiremu ebizibu ebi? Kandi abaana shi baawe?**
Seasonality and trends over time **Empindahinduka nembera ayenyima yobwire**	What are the current challenges of this season? **Ni bizibu ki ebiriho omumbera egi/ hatiya?**	
	Does weather impact what you eat? **Embera yobwire nekwata ahabimurikurya?**	How? **Eta?**
	Is food security worse now than before? **Okwerinda kwebyokurya hona hati kuri kubi kusinga enyimaho?**	What about when you were in the forest? **Kandi obumwabire muri omukibira?**
	Do you think that in the future it will be easier to provide food for your family? **Notekyereza ngu omubwire bwomumeisho nikiza kukwanguhira kutunga ebyokurya byeka yawe?**	Do you think it will be worse? Or the same? Why? **Notekyereza ngu nikyiza kuguma kusingaho ninga tiharabeho empinduka? Ahabwenki?**

Appendix VI - Key informant interview guide

Section:	Questions:	Follow-up:
General:	What is your name? Where do you work?	
Burden of Food Security	Is food security a major concern in this area? For whom? Is there a difference between the Batwa and Bakiga in terms of food security? Why? Why do you think there is a difference? What are the negative outcomes in this area due to food insecurity? On an individual and household level? Do you think that food insecurity has led to severe malnutrition in the area? Even to death?	Does the magnitude and ability to cope vary between these two populations? What do you think the main differences are?
Risk Factors	Which families are most at risk for food insecurity in the area? Do they tend to have other negative health outcomes? Based on previous research, traditional forms of wealth do not significantly impact food security, Can you tell me what you think are the major predictors? Do social networks play a role in food security? How?	What kind of wealth? Why do you think that is?

	Do you know how the Batwa access food? Grow, Buy or Trade?	
Seasonality	Is food insecurity more severe at different times during the year? When? Why? Does weather impact food security (rain, wind, drought, temperatures etc.?) Do you think that food insecurity is getting better or worse overtime?	
Adaptation	When households or individuals are food insecure what do they do? Do the Batwa have different coping strategies than the Bakiga?	How can people access food if they run out? Are these more or less effective? How come?
	Thank-you very much for your time and knowledge we sincerely appreciate your help. If you would like we can contact you once the results are complete would you like us to follow-up with you?	

Appendix VII - Seasonal variation of household food insecurity indicators

Table: Seasonal variation of household food insecurity indicators among the Batwa of Kanungu District, Uganda (January 2013-April 2014)

Food Security Question	Total (n)	Odds Ratio[1]	Dry (January & July)		Rainy (April, November)	
			Yes	No	Yes	No
Worried food would run out	763	1.33 (0.76-2.31)	359 (93)	29 (7)	343 (91)	36 (9)
Food bought didn't last	763	1.55 (0.94-2.57)*	359 (93)	29 (7)	337 (89)	42 (11)
Couldn't afford balanced meals	764	1.07 (0.65-1.75)	349 (90)	39 (10)	339 (89)	40 (11)
Lesser quality foods for *children*	681	0.51(0.28-0.92)**	311 (90)	36 (10)	315 (94)	19 (6)
Couldn't feed *children* balanced meal	681	0.75 (0.45-1.22)	303 (97)	44 (13)	301 (90)	33 (10)
***Children* were not eating enough**	681	0.88 (0.54-1.44)	304 (88)	43 (12)	297 (89)	37 (11)
Adults skipped meals	756	1.00 (0.73-1.38)	274 (71)	114 (29)	267 (70)	112 (30)
Adults skipped more than one meal in the past week	767	0.92 (0.66-1.26)	280 (72)	108 (28)	280 (74)	99 (26)
Adults ate less than they felt they should	766	1.32 (0.89-1.93)	321 (83)	67 (17)	299 (79)	80 (21)
Adults were hungry	765	1.47 (1.06-2.01)**	270 (70)	118 (30)	234 (62)	145 (38)
Adults lost weight	757	1.16 (0.85-1.60)	267 (69)	121 (31)	249 (66)	130 (34)
Adults did not eat for whole day	767	1.49 (1.10-2.03)***	208 (54)	180 (46)	171 (45)	208 (55)
Adults did not eat for more than a whole in the past week	767	0.97 (0.72-1.31)	179 (46)	209 (54)	179 (47)	200 (53)
Cut size of *children*'s food	681	0.92 (0.56-1.53)	308 (89)	39(11)	299 (90)	35 (10)
***Children* skip meals**	681	1.24 (0.91-1.70)	202 (58)	145 (42)	178 (53)	156 (46)
***Children* skipped more than one meal in the past week**	681	1.05 (0.76-1.45)	163 (47)	184 (53)	153 (46)	181 (54)
***Children* hungry**	681	0.96 (0.70-1.32)	200 (58)	147 (42)	195 (58)	139 (42)
***Children* not eat for whole day**	681	1.16 (0.84-1.60)	146 (42)	201 (58)	123 (39)	205 (61)

*0.10 ** 0.05 ***0.01

[1] Odds Ratio *results of the unconditional univariate logistic regression models, using a random intercept to control for repeated household measurements among the Batwa Pygmies of Kanungu District, Uganda, October 2012-April 2014*