Animal and Human Health for the Environment and Development
Great Limpopo Trans Frontier Conservation Area,
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# Pathogens, Parks and People: Assessing the Role of Disease in Trans-Frontier Conservation Area Development


Prepared by
**Claire Geoghegan [1]**



On behalf of

Lovemore Mugabe [2], Dr. Alex Caron [1,3], Professor David Cumming [4],
Professor Wayne Getz [1,5], Dr. Michel de Garine-Wichatitsky [3], Dr. Mark Robertson [6]
& Professor Elissa Cameron [1]

1. Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa
2. University of Harare, Harare, Zimbabwe
3. CIRAD UR AGIRS, 37 Arcturus Road, Highlands, Harare, Zimbabwe
4. Tropical Resource Ecology Programme, Biological Sciences, University of Zimbabwe
5. Department of Environmental Science, Policy and Management, College of Natural Resources, University of California - Berkeley, USA
6. Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa

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# Abstract

Disease is a major burden for conservation and regional development in sub-Saharan Africa. Many countries struggle to control human infectious diseases like tuberculosis and HIV / AIDS, while the introduction of exotic zoonotic pathogens, like bovine tuberculosis, can impact on wildlife conservation (Bengis, 2005), agriculture, trade and human health. Zoonotic diseases that pass between animal and human populations account for up to 75% of human illness (Taylor, 2001) but are often under-reported in rural areas where there is poor access to medical and veterinary healthcare.

Trans-frontier conservation areas, like the Greater Limpopo TFCA are designed to facilitate wildlife conservation and local economic development in marginalised areas through wildlife and culture-based tourism. However, the subsequent amalgamation of national parks, conservancies, private and communal lands across former private and international borders alters the movement and potential contact between wildlife, people and livestock across a broad landscape. Of particular concern is the potential for disease to be transmitted across species and between these groups into areas currently regarded as ‘disease free’.

Covering 100,00km$^2$ across three countries, many people and animals within and adjacent to the GLTFCA reside in remote areas with poor access to health care. The introduction or increase of disease in these areas poses a threat to rural community health and livelihoods, where people rely heavily on livestock for food and financial security. And, as many of these communities are at an increased risk of zoonotic infection due to the high levels of HIV/AIDS and tuberculosis in southern Africa, it is essential that the links between animal and human health are acknowledged and used to prevent disease impinging on the success of the TFCA development (Kock, 2005).

As there are currently no formal guidelines for disease management in the GLTFCA (Cumming 2003), this project aims to support policy development through identifying practical risk factors for zoonotic disease transmission in GLTFCA communities. Here, we will present details of research conducted in three communities neighbouring Gona-re-Zhou National Park within the GLTFCA in southern Zimbabwe. We will discuss the practical risk factors of disease transmission between wildlife, livestock and human populations based on local farming, agricultural and natural resource use activities; and provide feedback from local focus groups on their perceptions of disease and other issues relating to their proximity to the GLTFCA.

# Contents

# Section1: Introduction

## 1.1 The Great Limpopo Trans-Frontier Conservation Area (GLTFCA)

The Great Limpopo Trans-Frontier Conservation Area was established in December 2002 (See Figure 1). The GLTFCA covers three countries and spans 100,000km$^2$. This includes 35,000km$^2$ of national parks in **Mozambique** (Limpopo, Banhine and Zinave), **South Africa** (Kruger) and **Zimbabwe** (Gona-re-Zhou), and an additional 65,000km$^2$ of private game reserves, hunting conservancies and intervening areas of commercial and communal land. As 55% of land within the GLTFCA is currently under communal tenure, land use is dominated by various forms of small-scale agro-pastoralism.

The GLTFCA is predominantly characterized by low altitude savannah ecosystems, and four main vegetation types; Mopane woodland, shrubveld, sandveld and riverine woodland (Great Limpopo Park Website, 2007a). The area is intersected by the Lebombo Mountains and 4 major rivers (Cumming 2004), and has high mean temperatures and low rainfall, with regional flooding and drought events.

When combined, the GLTFCA ecosystem supports over 147 mammal species, including **18 Red Data Book threatened and endangered species**, 505 bird, 2000 plant, 39 fish and 34 frog species (Great Limpopo Park Website, 2007). Species distribution has been aided through the translocation of 3, 885 of a planned 6,000 animals from South Africa, to repopulate areas in Zimbabwe and Mozambique that were previously affected by war and disease (Peace Parks Website, 2007). However, little is known regarding the current disease status of animals residing in much of this area.

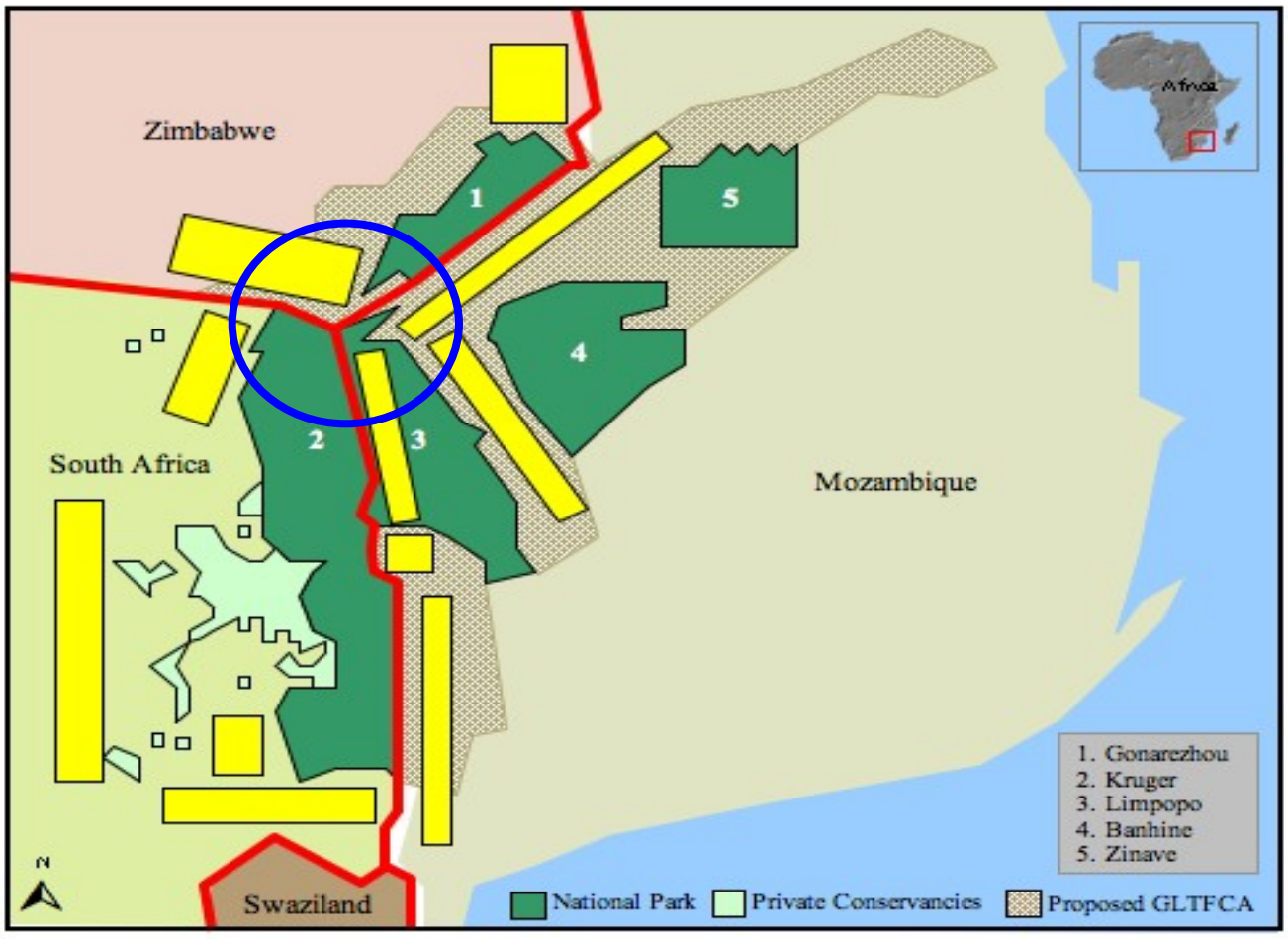


**Figure 1**: Map of the GLTFCA study area, showing National Parks, communities and potential study sites in Mozambique, South Africa and Zimbabwe.

## 1.2 The Rationale for TFCA Development

Although some may be argue that TFCA development is politically driven, the removal of fences between former park, private and communal areas, and across national borders, reconnects fragmented landscapes to form contiguous ecosystems suitable for wildlife and biodiversity conservation. TFCA's are also intended to drive economic and social development in marginalized areas, through improved access to regional resources, and revenue derived from enhanced and more accessible wildlife and cultural-based tourism.

Within the GLTFCA, tourism activities are currently well-established in the Kruger National Park, South Africa (Cumming, 2004), which cater for over 1 million visitors per annum. To facilitate the transfer of these revenues to areas throughout the GLTFCA will be a challenge. However, the development of new concessions and international border posts between the three countries may improve access to areas previous unreachable due to poor regional infrastructure. The addition of border gate fees contributes additional revenue for conservation activities, which is hoped will increase during locally hosted international events, like the FIFA Soccer World Cup in 2010 (Cumming, 2004). It is estimated that regional improvement in infrastructure and tourism hospitality facilities will provide an additional 61,000 conservation-dependent jobs for local people, and help to support regional development, especially in Zimbabwe which is currently experiencing severe economic decline (Cumming, 2004).

## 1.3 Issues of Concern within the GLTFCA

### 1.3a Human Livelihoods

Greater than one million people, and their livestock, live within the new GLTFCA boundaries, as shown in yellow on Figure 1. Livestock and wildlife production is generally agreed to be the most suitable land use, which has been used as a source of income in the Limpopo valley since 600 AD (Jansen *et al.* 1992, Plug, 2000). As food security is poor, many communities rely *solely* on livestock and domestic animals, including cattle, goats, sheep, pigs, chickens, donkeys, cats and dogs for their livelihoods and economic security. However, as the communal lands are over-populated, natural resource use and agro-pastoral activities are often insufficient to support families, leading to high levels of migration for labour opportunities outside the area. (Collinson *et al.*, 2001; Agincourt, 2007). In order to improve and develop infrastructure in these areas, greater employment opportunities and productivity are needed in both the short and long-term (Cumming and Slotow, 2003).

### 1.3b Health and Disease

According to research conducted by Taylor *et al*. (2001), **75% of human illnesses are zoonotic and attributed to animals**. However, 54% of livestock pathogens, and 44% of human pathogens can infect wildlife, where it is twice as likely to cause an emerging human disease, given the correct environmental circumstances. As disease emergence is often linked to changes in land use, agricultural practices, human demographics and climate, coupled with poor access to health care and food, and high incidence of drug-resistant pathogens and HIV/AIDS (Woolhouse *et al*. 2005), **communities in and around the GLTFCA are at high risk of infection**.

Research conducted by the South African National Park wildlife veterinary teams, and students from the Universities of Pretoria, South Africa, and California – Berkeley, USA (Bengis, 2005; Cross *et al.* 2005; Michel *et al.* 2006) indicates that the spread of alien zoonotic pathogens like bovine tuberculosis has already had an impact on buffalo, lion and other wildlife populations with Kruger National Park, South Africa.

Similar research conducted in Zimbabwe and Mozambique show different, but equally dangerous pathogens in wildlife, including rabies, anthrax, brucellosis, canine distemper and Foot and Mouth Disease, all of which may be transmitted to and from domestic animals and local communities. As fences between these countries and parks are removed, it is anticipated that the movement of wildlife across former borders will spread these and other diseases to populations in areas that are currently 'disease free'. With no current information on the levels of these pathogens in communities and livestock, it is impossible to quantify or reduce the impact that zoonoses may have at the wildlife, livestock and human health interface.

Research conducted elsewhere in southern Africa suggests diseases that affect the health of families and their livestock, often lead to household instability, loss of education, and a change in land use and natural resources to compensate for lost incomes. This may lead to increased use of bush meat and plant materials for food, shelter materials, and traditional medicine for people and animals.

Increasing levels of disease may also hinder the success of the GLTFCA due to the **perceived threat of disease transmission** from wildlife to local communities and their livestock. This risk may also be perceived by tourists, and may affect use of the GLTFCA, regardless of the actual level of risk. Loss of international **trade** due to food regulations and reduced revenues due to restricted animal movements and cancellation of wildlife auctions will also hinder the financial basis on which park activities depend.

Control of zoonoses will require careful surveillance, consistent health care, control and containment, alongside community outreach, harmonised transboundary animal and human health policies, and support for areas that are less able to cope with these increased demands on resources. These significant costs will require revenue derived from multiple sources, but will play a crucial role in supporting the sustainability of the GLTFCA.

## 1.4 Human Health in the GLTFCA

Health and disease issues, including high levels of malnutrition, HIV / AIDS, tuberculosis and malaria, are compounded by poverty, poor infrastructure, changing agricultural and land use practices, and lack of development and health care facilities throughout the GLTFCA (Woolhouse *et al*. 2005). These factors have reduced life expectancy to 37 years in Zimbabwe, and contributed to a decline in living standards throughout the GLTFCA (Agincourt, 2007).

High levels of infectious disease have changed the size and composition of households as families fail to cope with the increasing costs of health care and loss of income through the mortality of breadwinners. Less money for daily expenditures, including food, drives land use change and increases household reliance on natural resources to supplement diet, fuel and housing material needs (Agincourt, 2007). These **desperate and unsustainable practices** have a direct impact on the conservation of natural resources throughout the GLTFCA and place pressure on the natural ecological systems of the region. An increase of disease in humans, livestock or wildlife in the area would lead to further declines in ecosystem health that is required for successful regional conservation.

## 1.5 Animal Health in the GLTFCA

Animal health in the GLTFCA is affected by a severe lack of health services, poor grazing land and the spread of new diseases like trypanosomiasis, brought by tsetse flies to areas warmed by climate change. Other exotic and alien diseases like bovine tuberculosis and Foot and Mouth Disease, were introduced into the area by foreign livestock brought by European settlers during the last 150 years (Cumming, 2004). Local indigenous livestock breeds are less resistant to these imported diseases, the impact of which can devastate community agriculture and household livelihoods. As there is currently **no formal policy on animal health**

**and disease control for the GLTFCA**, the responsibility for animal health falls to local veterinarians where possible (Cumming, 2004). By conducting research on the presence or absence of disease, practical risk factors for infection, and community perception of disease risk, this project aims to provide information that can be used by the GLTFCA Joint Management Board and other authorities, to develop policy for collaborative human and animal health surveillance within the GLTFCA.

## 1.6 Animal and Human Health for the Environment and Development (AHEAD)

The GLTFCA-AHEAD group was established in 2003 at the V$^{th}$ World Parks Congress in Durban, South Africa, with the assistance of the Wildlife Conservation Society. (See the website for more information http://www.wcs-ahead.org/workinggrps_limpopo.html).

The objectives of this group are to:

*'Facilitate development and conservation success in the GLTFCA through **integrated understanding** based on innovative **inter-disciplinary applied research**, monitoring and surveillance at the **interface between wild and domestic animal health,** ecosystem goods and services, and **human livelihoods and well-being**.'*

A conceptual framework aims to guide the activities of the GLTFCA-AHEAD working group, which covers six themes with inter-related sub-themes. This project falls with, and aims to contribute to five of these themes, including:

- Theme 2: **Animal Health and Disease**
  Objective: to obtain basic information on incidence of spatial and temporal patterns of disease for wildlife, domestic animals and humans

- Theme 3: **Land Use, Ecosystem Goods and Services and Animal Health**
  Objective: to ground truth livestock numbers, conditions and disease status

- Theme 4: **Human Livelihoods, Animal and Ecosystem Health**
  Objective: to quantify the plausibility of alternative livelihoods, current benefits and costs compared to alternative futures

- Theme 5: **Policy Support, Capacity Building and Local, National and Regional Scales**

- Theme 6: **Communication and Outreach**

These objectives overlap with priorities for research outlined by the GLTFCA Joint Management Board, Conservation and Veterinary Sub-Committee, which include:

1. Human disease surveillance through clinics and rural hospitals
2. Inventory of human, livestock and wildlife populations in TFCA
3. Spatial analysis of data, identify potential disease hotspots and land-use conflicts

And with those of SELCORE, an operational platform for 3 University departments, 5 rural district councils, the private wildlife sector and 4 NGO's in Zimbabwe's South East Lowveld:

1. To align research with the needs of local people
2. To assist with dissemination of research findings

# Section 2: The Project

## Pathogens, Parks and People:
## Assessing the Role of Disease in Trans-Frontier Conservation Area Development

## 2.1 Overall Goal

To identify the risk of zoonotic disease transmission at the interface between human, livestock and wildlife populations in the GLTFCA, southern Africa.

## 2.2 Specific Objectives

1. Delineate the local practical risk factors for transmission of bovine tuberculosis and other zoonotic diseases between wildlife, livestock and human populations in the GLTFCA (Themes 2, 3 & 4)

2. Record the current disease concerns affecting wildlife, livestock and people in the GLTFCA. (Themes 2 & 3)

3. Record the awareness of zoonotic disease risk of local people and health providers in the GLTFCA (Themes 2, 3, 4 & 6)

4. Provide estimates of current and potential impacts of zoonotic disease on the health of communities, livestock, and conservation initiatives, to be used for disease policy development within the GLTFCA.(Themes 2, 3, 4, 5, & 6)

These aims are designed to capture locally relevant information, which together with data collected by veterinary and medical health professionals within and adjacent to the current parks, can be used to develop effective health and disease policies for the GLTFCA. It is also intended to build relationships between health providers and local communities, to help mitigate disease risks for wildlife, livestock and people within a changing land use of the GLTFCA.

## 2.3 The Research Team

To accomplish these objectives we developed a team of multi-disciplinary scientists and students from three countries. This was aided through the development of Memoranda of Understanding between institutions under the AHEAD-GLTFCA working group.

This project aimed to build local capacity through the involvement of local students, who along with other project participants, were exposed to a range of theoretical concepts that traditionally fall outside their individual study fields. The interaction between members of this team helped to broaden our overall understanding of issues surrounding health and conservation. Working in trans-disciplinary and multi-national teams also removed institutional barriers and helped develop a forum for the exchange of knowledge and ideas. This experience led to more holistic collaboration, which should benefit future conservation research in southern Africa.

The team consisted of partners from:

Zimbabwe

- CIRAD
  - Research Platform - Private Community Partnership
- University of Zimbabwe
  - Centre for Applied Social Sciences (CASS)
  - Geography Department
  - Veterinary Department
  - Tropical Resource Ecology Programme, Department of Biological Sciences
- National University of Science and Technology (NUST)

South Africa

- University of Pretoria
  - Mammal Research Institute, Department of Zoology and Entomology

United States of America

- University of California - Berkeley
  - Department of Environmental Science, Policy and Management, College of Natural Resources

## 2.4 Project Methodology

Two methods of data collection were used in during this project;

1. Questionnaires, conducted at the household and individual scale
2. Participatory Focus Groups, conducted in communities within the GLTFCA

This methodology was designed to capture information from individual, household and community scales over a wide spatial area.

In recognition that communities around the GLTFCA differ culturally, socially and in terms of their lifestyles and livelihoods, each questionnaire was adapted for greatest relevance to the local conditions. These adaptations were made after initial field site visits, and on the advice of local research partners. Information on this process is available in the Mid-Term Seed Grant Report for this project, available on the WCS AHEAD-GLTFCA website (http://www.wcs-ahead.org/workinggrps_limpopo.html).

## 2.5 Design

### 2.5a Questionnaires

The questionnaires used in the project were designed to capture a range of lifestyle, geographical and natural resource data; and were developed in collaboration with partners from:

- Social science (*questionnaire development, training of interviewers, demographic analysis*)
- Zoology, biology and veterinary science (*animal disease analysis*)
- Botany (*traditional medicine analysis*)
- Medicine (*human health analysis*)
- African languages (*questionnaire interpretation*)
- Mathematics and economics (*questionnaire statistical interpretation and model development*)
- Geography (*GIS map development*).

This ensured that questionnaires were of a high-quality and compatible with data entry and analysis software. These collaborations also helped to build better relationships between park managers, veterinarians, health professionals, scientists and communities, which are so often separated.

Two questionnaires were developed for use in a range of interviewing scenarios.

1. Short questionnaire
   Comprised of 40 questions, designed for an individual response under short time conditions at animal health diptanks or human clinics.

   Interview duration: approximately 15 minutes

2. Comprehensive questionnaire
   Comprised of 150 questions, designed for a household response under longer time conditions, and typically administered at the household.

   Interview duration: approximately 1.5 hours.

All interviews were conducted by local students in the most appropriate local language, with the use of a local interpreter when necessary. Each questionnaire includes a mixture of open (qualified) and closed (quantified) questions that become increasingly detailed depending on the initial response. Feedback loops were included in each section to verify the authenticity of answers that were critical to understanding specific disease risks. Participant confidentiality is maintained through the use of an independent numbering system, which will permit household follow-up if necessary, but prevents the generation of household-specific information on completion of the data analysis.

To allow analysis of the project objectives with respect to the AHEAD-GLTFCA conceptual framework themes, questionnaires focused on:

- Household Health and Demographics
- Household Income and Food Security
- Animal Health
- Natural Resource Use (water, food, medicine, shelter)
- Agricultural Practices
- Animal and Animal Product Use (meat, milk, dairy)
- Animal and Human Movement and Migration Patterns
- Human, livestock and wildlife contact (water, grazing areas, homesteads)
- Human and Animal Health Service Access and Use
- Economic Impacts of Disease
- Perceptions of Disease
- Perceptions of the GLTFCA

These questionnaires were successful in capturing the information required to investigate health scenarios outlined within the project objectives.

## 2.5b Participatory Focus Groups

Focus groups were used to provide a broader scale analysis of local conservation, agricultural and health related issues, and to complement and enhance the information obtained through individual and household questionnaires. This method was intended to provide a less formal and more discursive opportunity to obtain community feedback on the categories included in the questionnaires. A baseline for this methodology was taken from similar research conducted in South Africa and Kenya, with advice from groups working in the local area (Leyland and Catley, 2002).

Focus groups were offered as a voluntary activity to local community residents, and members of local organization already operating in each area. This was co-ordinated to minimize inconvenience and maximize the benefit to community members, being conducted alongside and in collaboration with local community initiatives and farming associations operating in each area. This facilitated greater contact between communities, health care providers and researchers, which may provide an incentive for locally driven health liaisons beyond the duration of the project.

Each focus group was conducted using an open format, with conversation directed towards conservation, disease awareness and perceptions of the GLTFCA. Open participatory techniques were used to quantify land and natural resource use patterns that may influence the potential risk of disease in each

community. Overall, this method was an effective method of communication and feedback with each study area; the results of which will be reported separately after more detailed analysis.

## 2.6 Project Implementation

Although this project initially aimed to represent communities in all three GLTFCA countries, due to the short time duration, and extraordinary size of the GLTFCA, we decided to focus on one area close to tri-country boundary. This resulted in more focussed and cost-effective activities, and concentrated on understanding health issues in an area of the GLTFCA with high potential for tourism, cross-boundary movement of people and animals, and a mixture of communal, private hunting conservancies and national park lands.

A total of 200 questionnaires and five focus groups were conducted within the GLTFCA, up to 15km from the current boundaries of the Gona-re-Zhou National Park (GNP), which is estimated to be the maximum distance that people will travel to access health care facilities (Tanser, 2000). All participants gave their consent to be interviewed, which was provided as a voluntary activity at animal health diptanks and through prior arrangement at households.

As a number of our collaborators have worked in these areas before, the information collected as part of this project can be assessed with respect to other factors associated with land use and health in the GLTFCA. As research in these areas is also complicated by poor infrastructure, accessibility, communications, and access to fuel and food, by working with existing research partners, these difficulties were minimised, allowing more time to be spent on the research.

## 2.7 Timeline

The majority of the activities for this project were conducted between January 2009 and February 2010 (See Figure 2).

## 2.8 Project Activities

### 2008

Seed Grant Application

### 2009

- January - Collaboration protocol development
- February - Questionnaire design and development
- March - Present project protocol at the AHEAD-GLTFCA Meeting in Mozambique.
  - First field visit with CIRAD to communities and health facilities bordering Gona-re-Zhou National Park, Zimbabwe
- April - Questionnaire adapted to increase local relevance, based on results of initial field visits
- May - Student training
- June - Mid-term project report submitted to GLTFCA-AHEAD
- July - Community liaison in preparation for field work
- August - Field work (Household surveys)
- September - Data entry and initial analysis
- October - Data entry and preparation for field work and community workshops
- November - Field work (diptank questionnaires, community focus groups)
- December - Data entry and analysis

### 2010

- January - Data entry and analysis
- February - Present project results at AHEAD-GLTFCA Meeting in South Africa
  - Final Seed Grant report submitted to GLTFCA-AHEAD

## 2.9 Ongoing Activities

Due to the large volume and fine scale household data collected during this project, data analysis will continue after the submission of this report. Publications based on this work will be prepared where appropriate. The pooled results of the survey will be made available to communities, health care providers, park management and other interested parties through collaborating organisations on completion of analysis.

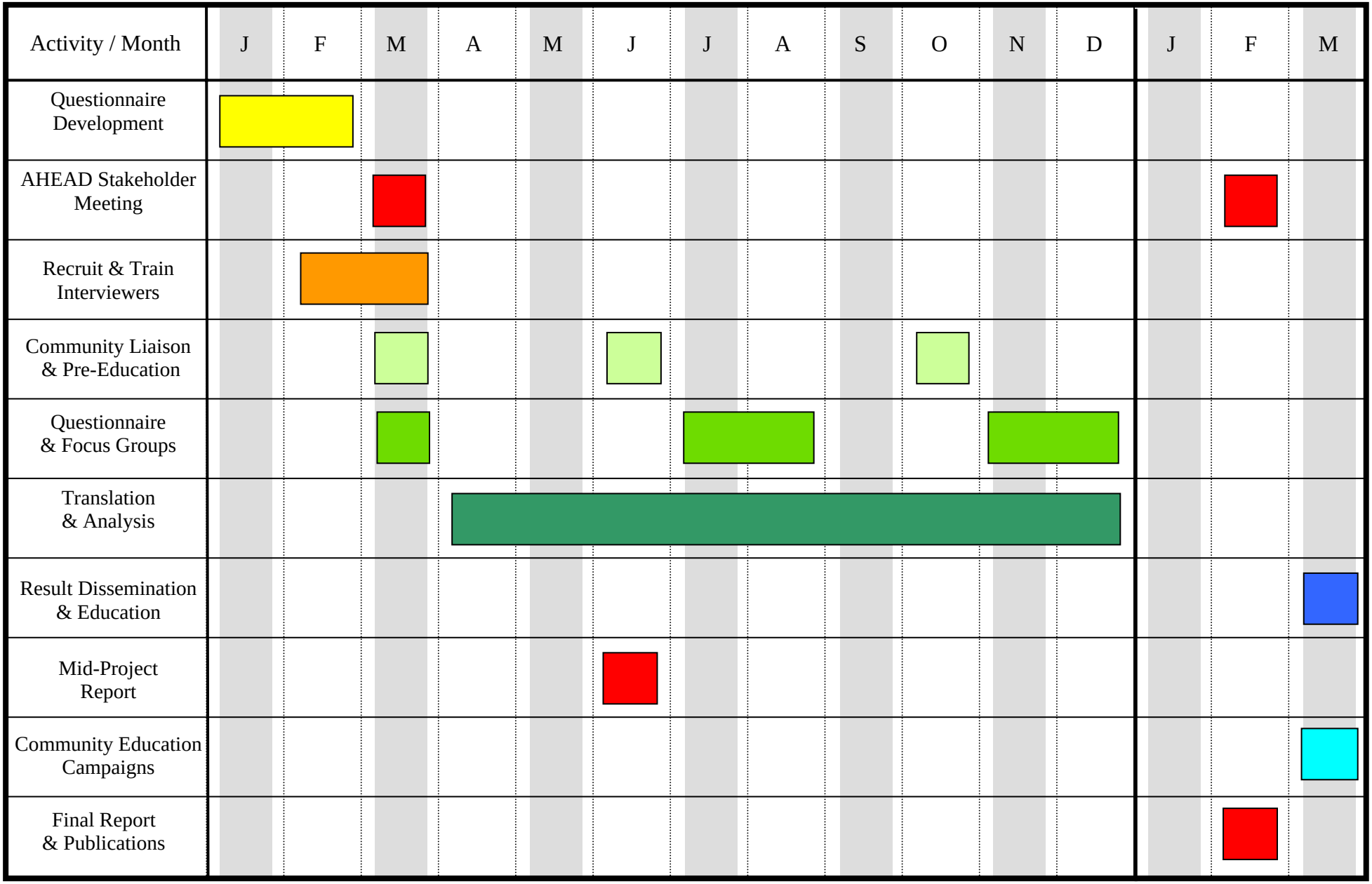


**Figure 2**: Timeline of Seed Project Activities, January 2009 - March 2010

# Section 3: The Study Area

## 3.1 Gona-re-Zhou National Park

Gona-re-Zhou National Park (GNP) means '*Place of the Elephants'* in the local language, Shona, and spans 5,032km$^2$, making it the second largest park in Zimbabwe. GNP is divided into two areas, the northern Save / Runde, and south western Mwenezi, and borders Mozambique to the East (See Figure **). Four rivers pass through or border the park, all of which drain or join the Indian Ocean east of Mozambique. The Sengwe corridor separates the park from South Africa, although there is little to prevent movement across international, park and river boundaries along these borders. GNP was formed in 1975 by uniting former hunting areas, reserves and tsetse fly control corridors. Much of this land was originally communal, where livestock farming formed the most suitable land use due to low rainfall and drought events affecting arable agriculture.

GNP is bordered on the south west by the Sengwe Hunting Conservancy (SHC), which operates in land between the park and communities. The GNP and SHC fence lines are mostly poorly maintained, or have been removed over many years (See photograph below). Wildlife, livestock and people can pass with relative ease between park and surrounding communal lands, especially along rivers, which has the capacity to increase the levels of human – wildlife conflict, use of bushmeat to support diet and medical needs, and disease transmission between groups.

The park was closed to the public during the Rhodesian war, and much of the Mozambique civil war, but reopened in 1994, where two main camps provide opportunities for wildlife-based tourism. Although civil unrest and poaching have been constant within these areas for many years, a wide range of terrestrial and fresh-water species can be seen. These include wild dogs, rhinoceros, elephant, buffalo, giraffe, zebra, impala, nyala, bushbuck, kudu, Lichenstein's hartebeest, suni antelope, lion, hyaena, leopard, striped king cheetah, warthog, baboons, the Zambezi shark and lungfish. When combined, the GLTFCA hosts over 500 species of bird, 147 mammals, 116 reptile, 49 fish and 34 frog species.

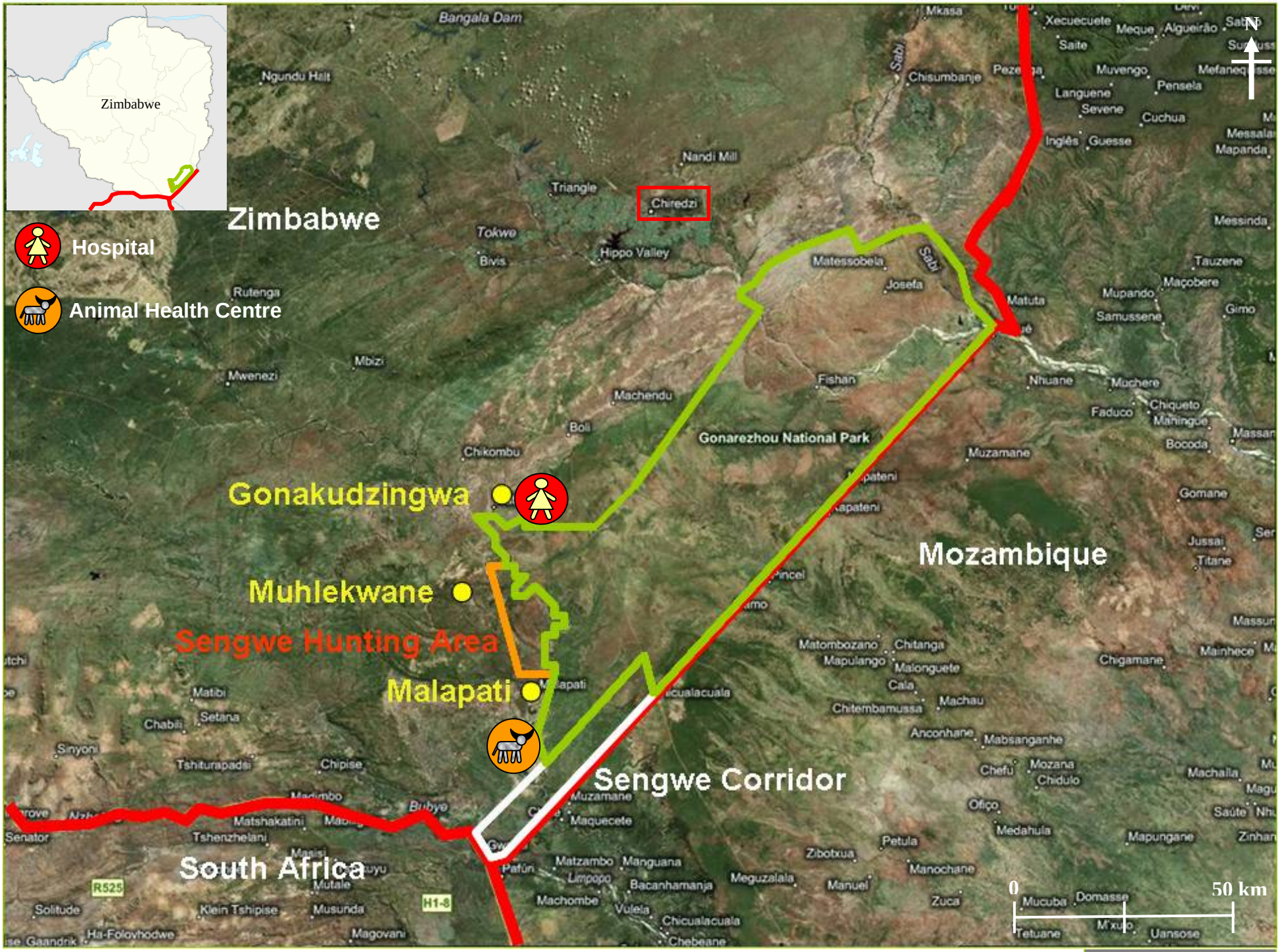


**Figure 3**: Map of the Study Area, showing the international borders between Zimbabwe, Mozambique and South Africa; Gona-re-Zhou National Park; Sengwe Hunting Area; the Sengwe Corridor; and the three project study sites (shown in yellow)

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## 3.2 Tourism

It is not possible to travel to GNP directly from Limpopo or Kruger National Parks, with most tourists being diverted through Beitbridge border post in South Africa. This adds an additional 100km's to the journey, which combined with basic facilities at two main camps, may prevent some people visiting the park. The closest large town in the area is Chiredzi, which is situated north of the park, in Masvingo province (See Figure 3)

## 3.3 Local Disease and Health Care

### 3.3a Wildlife Disease

Wildlife populations in GNP are monitored by the Zimbabwean Wildlife Veterinary Unit, Division of Livestock and Veterinary Services, along with assistance by South Africa National Parks (SANPARKS). Recent research presented at the 2010 GLTFCA-AHEAD meeting, in South Africa, suggest that park wildlife have been exposed to bovine tuberculosis, brucellosis and Rift Valley Fever (de Garine-Wichatitsky).

All of these diseases have also been identified in surrounding cattle populations, with the majority of these pathogens posing a threat to public health. It was also reported that strains of bovine tuberculosis match those isolated from wildlife species in Kruger National Park, South Africa. This suggests that transmission of BTB has now occurred across the former park boundaries into areas of Zimbabwe previously known to be free of disease (de Garine-Wichatitsky).

## 3.3b Livestock Health and Health Care Services

Ten animal health diptanks operate in communities around the southern section of GNP, although these may not function on a weekly basis depending on the availability of dipping chemicals, environmental and political conditions. Diptanks are co-ordinated by the main animal health office, which is located in Malapati on the border of GNP and SHC. This office does not have access to any motorised transport, so all animal health activities are conducted using bicycles or on foot. Over 762 households and 10,452 cattle are registered to use diptank facilities according to the Animal Health Centre officers, with 80% of known cattle attending at least once during 2008.

Farmers participating at diptanks, which include men, women and children, are issued with a stock card to record information on increases and decreases of stock, and mortalities. This information is collected by hand and due to the lack of telephone and computer communication systems, is sent by postal mail to the district office in Chiredzi and the provincial office in Masvingo. Each diptank has a committee comprising of 7 local people, who liaise with local communities on behalf of the local animal health professionals. Committee members also provide information on vaccination programmes, which in 2009 included inoculating dogs and cats against rabies, and cattle against Foot and Mouth Disease (FMD).

The top four diseases reported to the Animal Health Centre in 2008/09 were:

1. Gall Sickness
2. Black Leg
3. Anthrax
4. Heart water

## 3.3c Human Health and Health Care Services

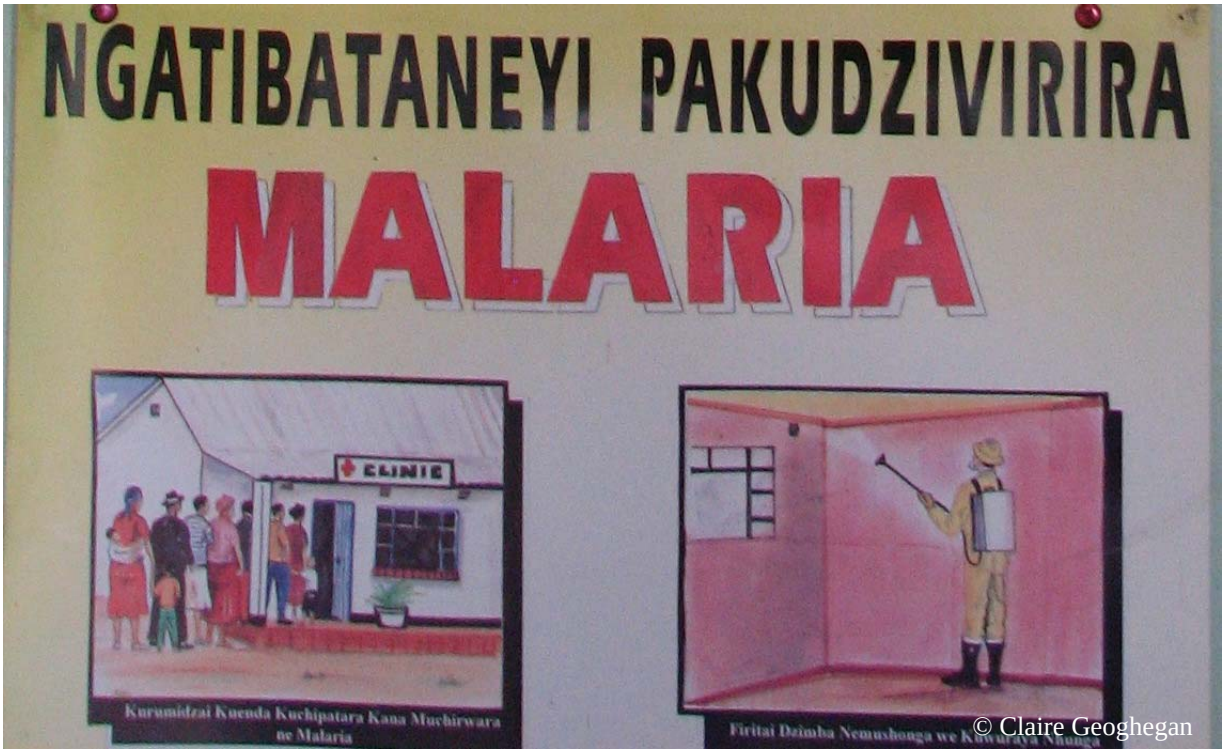
14 local clinics and one hospital are located in communities around the southern half of GNP. Clinics are staffed by qualified nurses, who are available for basic triage, infectious disease testing and distribution of medicines. Few clinics receive back-up from doctors as these are located at the main hospitals, the closest of which is in Chikombedzi, up to 52km away. Lack of transport in this region prevents many patients attending clinics, so community health workers travel by bicycle or on foot to reach patients who cannot travel. Wooden scotch carts pulled by donkeys are used to transport sick patients to the nearest hospital in Chikombedzi, which is 52km from Malapati, or the district hospital in Chiredzi (130km).

Although clinics operate a daily service, lack of transport and telephone communication systems often results in poor supplies of drugs needed to treat infectious diseases, including malaria, tuberculosis and HIV / AIDS. As these illnesses require a consistent drug regime, the health care of many patients cannot be managed sustainably using the current system.

Malaria was reported as the primary illness by all nurses interviewed at clinic level, where they diagnose patients using a rapid test. Due to the large number of Malaria infections, DDT has been used locally to reduce transmission by mosquito vectors. However, this is believed to be responsible for a rise in stomach illnesses, and cattle mortalities due to improper use of the chemicals to treat wounds.

Patients with suspected TB are referred to the district hospital in Chiredzi for full diagnosis. Positive patients are then registered and receive medication on a monthly basis from their nearest local clinic. Similar procedures are followed for patients with HIV / AIDS. However, for many patients, the costs of transport and medication may prevent their access to healthcare or initial testing.

Clinic staff also prepare community health and education campaigns aimed at reducing the transmission of HIV/AIDS between mothers and babies. Nurses also report working with local animal health professionals when presented with dog bite wounds that may present risks of rabies infection.



## 3.4 Chikombedzi Hospital

Originally a Methodist Church Mission Hospital, this government run hospital is the closest facility for the majority of communities around southern Gona-re-Zhou National Park. Chikombedzi hospital offers a number of facilities including, x-ray, general surgery, maternity, paediatric and dental departments. The hospital also has a TB ward and specialist TB department, a pharmacy, laboratory, rehabilitation unit and a waiting area for expectant mothers who have travelled from communities in anticipation of giving birth.

During the project, 2 doctors were employed at the hospital, but along with most staff, were experiencing difficulties with remuneration, but continued to provide healthcare through their personal commitment. The hospital has no motorised transport, due to the disrepair of older ambulances and the inaccessibility and high costs of fuel. Chikombedzi hospital also served as a local **cholera** station during outbreaks in 2009, which required the sequestration of the TB isolation ward for the duration of the quarantine laws.

A number of programmes were in operation to provide testing and counselling for HIV / AIDS patients, which incorporated advice on sexually transmitted diseases at the Chikombedzi Youth Centre on the hospital site. This service was particularly well attended by local youths, who had the opportunity to socialise and receive support within a safe environment.

## 3.4a Tuberculosis

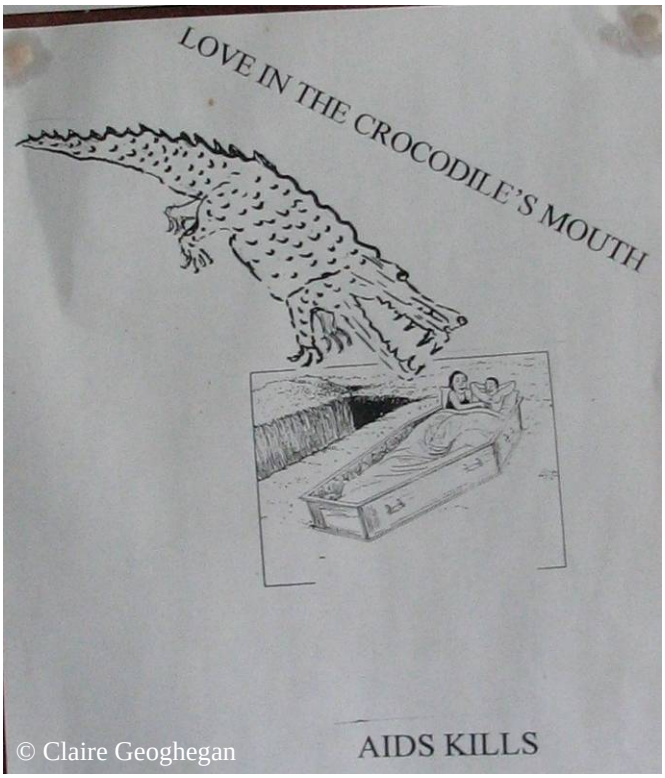
Although tuberculosis rates were decreasing in this area, shortage of food and other health issues have resulted in an increased case load. Patients referred by local clinic are diagnosed primarily by assessment of symptoms and x-rays, as sputum analysis was not available on site. Patients that default over the long course of treatment are often lost due to the difficulties and costs involved with getting to the hospital or clinics. Poor diet and high malnutrition was reportedly compromising the effectiveness of available drugs. Although the hospital had initiated a food garden for patients in 2008, low rainfall and access to water hampered the success in 2009. High levels of HIV/AIDS are also reported in the area, with 85% of tests conducted in 2008 giving positive results. Unfortunately, HIV/AIDS and TB are treated in separate hospital departments, despite high levels of co-infection.

## 3.4b Health Reporting

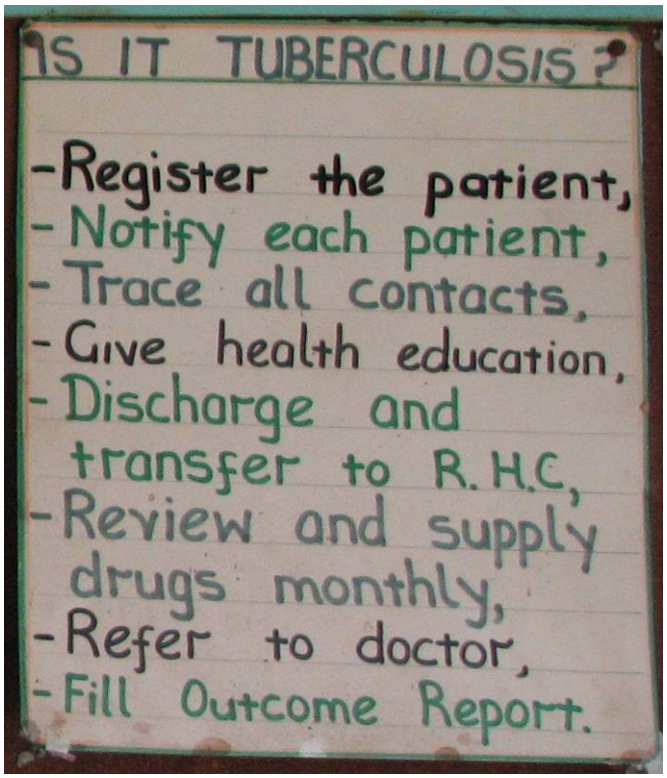
Quarterly summary reports for infectious diseases and other illnesses are compiled at the hospital's 'Health Information' department, and sent to the district and provincial offices, According to figures from 2009, the top 5 human health problems seen at the hospital are:

1. Malaria
2. HIV / AIDS
3. Injuries
4. Tuberculosis
5. Sexually Transmitted Diseases

With 3 of the top 5 human health problems attributed to infectious disease, and Malaria ranking as the top health concern for this area; disease will likely be affecting household resilience throughout the area. This will have a number of potential knock-on impacts on agriculture and natural resource use, and ultimately, conservation in the GLTFCA.








This hand-drawn map, located in Chikombedzi Hospital, highlights the connection between people and wildlife, depicted here by the inclusion of elephants and antelope on this 'Chikombedzi Catchment Area' Map.

## 3.5 The Study Sites

Three study sites were chosen with close proximity to animal health diptanks, along a gradient from Gona-re-Zhou Park and the borders with South Africa and Mozambique (See Figure 4).

### Site 1: Gonakudzingwa

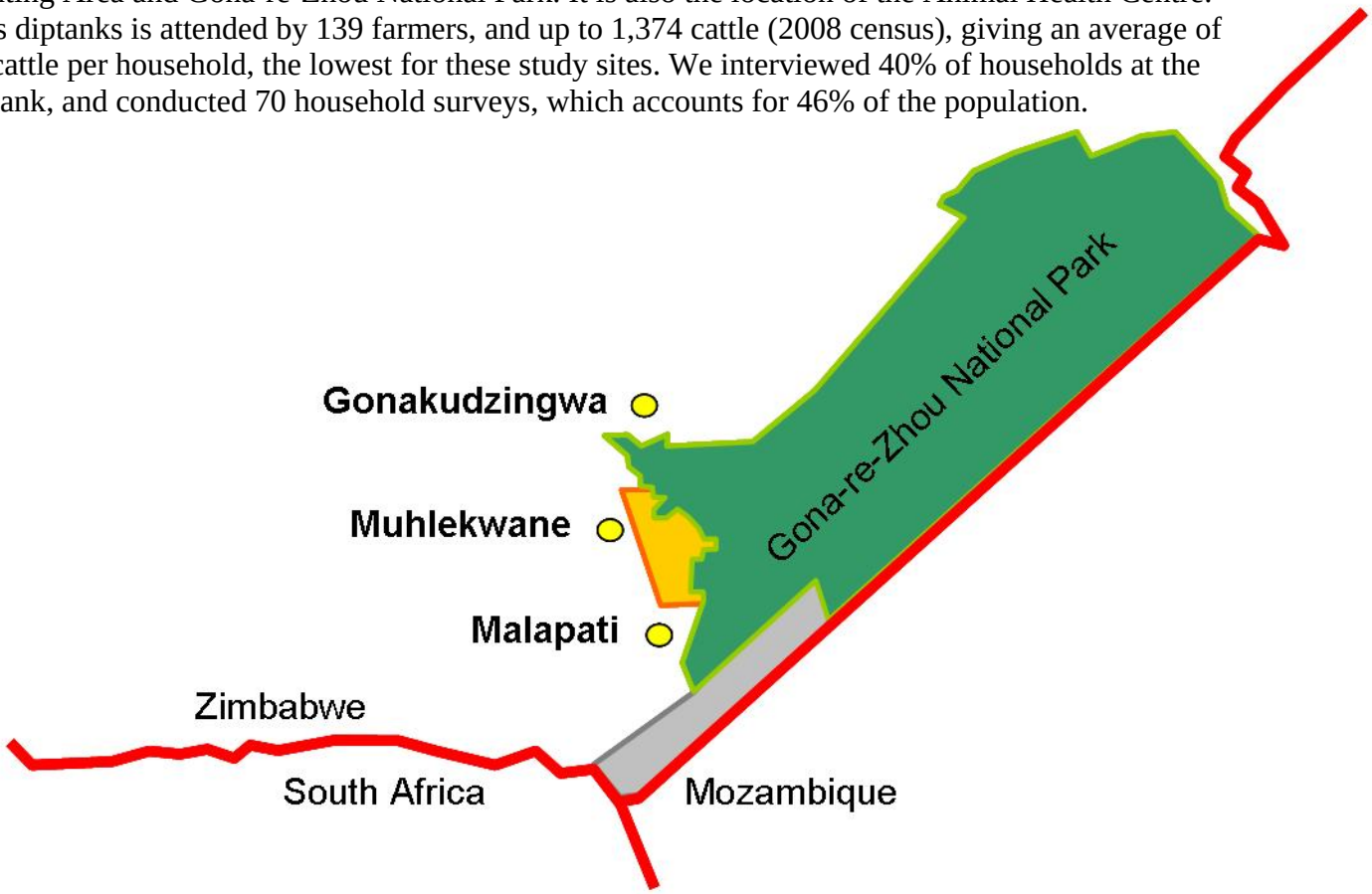
Characterised by commercially orientated agriculture, 14 farmers attend this diptank, with up to 1,200 cattle (2008 census). This averages to 86 cattle per household, which is the greatest for any study area. As this area has a small number of farms, we interviewed 80% percent of households to improve our confidence when interpreting the results. Gonakudzingwa is the closest site to a market town and hospital, located in Chikombedzi, which is a distance of ~ 5km. It is close to the border of Gona-re-Zhou National Park, but the furthest from the Sengwe Hunting Conservancy, Sengwe Corridor, and tri-nation boundary.

### Site 2: Muhlekwane

With equal distance to the Gonakudzingwa and Malapati study sites, this area represents a middle point based on the proximity to Gona-re-Zhou NP, Sengwe Hunting Area, Sengwe Corridor, the tri-nation boundary and the nearest hospital and animal health centres. Sixty-seven farmers attend this diptank, with up to 861 cattle (2008 census), giving an average of 13 cattle per household. We interviewed 34 farmers at this diptank, representing just over 50% of the population, and conducted 19 household questionnaires, accounting for 28% of residences.

### Site 3: Malapati

Malapati is the closest diptank to the tri-nation border (~ 40km), Sengwe corridor, Sengwe Hunting Area and Gona-re-Zhou National Park. It is also the location of the Animal Health Centre. This diptanks is attended by 139 farmers, and up to 1,374 cattle (2008 census), giving an average of 10 cattle per household, the lowest for these study sites. We interviewed 40% of households at the diptank, and conducted 70 household surveys, which accounts for 46% of the population.






## **Figure 4**: Study Sites

### A: Gonakudzingwa

Characterised by larger commercially-orientated farms; this area is situated close to Chikombedzi town, and approximately 90 from the tri-nation border

### B: Muhlekwane

An area with open grazing lands, close to Gona-re-Zhou NP, and approximately 65km from the tri-nation border.

### C: Malapati

Situated on the boundary of Gona-re-Zhou NP and Sengwe Hunting Area, farming practices are dominated by the close proximity of the Mwenezi River. This site is approximately 40km from the tri-nation boundary

# Section 4: Results

## 4.1 Household Demographics

In order to adapt the questionnaires for local social and cultural conditions, we obtained information at the beginning of the survey regarding the number of people who were originally from the study area. This also allowed us to assess the most widely-understood languages, and hire a multi-lingual interpreter for the Zimbabwean students, when necessary.

Of our respondents, all were **male** and aged between **15 and 81 years of age**. Although women and children are involved with livestock farming, all households chose to have a male spokesperson, despite the option of male or female interviewers.

## 4.2 Place of Birth

All three of the study sites had a **low percentage** of respondents who were **born in the same area**. Muhlekwane had the lowest (18%) with residents originally from 15 different areas, with a maximum distance of 300km. This is similar to Gonakudzingwa, were 20% of respondents were from the area, with the remaining originally from 7 localities up to a distance of 240km.

Although Malapati had the highest percentage of respondents originating from the area (48%), the remaining population were from **19 locations** up to **410km distance**. This may be due to the proximity of this area to the tri-nation boundary and traditional migration to work in the mines in South Africa. It may also reflect land redistribution and political events that have taken place in Zimbabwe over the last 20 years.

## 4.3 Languages

As a result of human population movements**, six local languages are spoken in the study areas**, with **Shangaan** being the most widely understood as first, second, third or fourth language. This accounts for 100% of households in Gonakudzingwa, 94% in Muhlekwane, and 57% in Malapati.

**Ndebele** is the second most widely understood language, with 60% comprehension in Gonakudzingwa, 59% in Muhlekwane and 45% in Malapati. **Karanga**, the third most widely understood language, is only mentioned as the primary language, with no households learning this as a secondary language. This reflects the Karanga as the most populous of Zimbabwe's ethnic groups, who are a sub-group of the Shona culture, and may account for 48% of households speaking **Shona** as their third language, it ranking fourth most understood overall.

**English** was mostly a **fourth language** where spoken, which only accounted for 10%, 15% and 3% of households in Gonakudzingwa, Muhlekwane and Malapati respectively. **Venda**, a South African language, was not spoken at the study site furthest from the South African border (Gonakudzingwa), but was understood by 3% of Muhlekwane, and 2% of Malapati households, making it the least widely understood language in the area.

## 4.3a Number of Languages per Household

As can be seen from Table 1, very few households understand only one language. However, despite the large number of people residing in Malapati who are originally from other areas, only 10% of households can understand more than 2 languages. In both Gonakudzingwa (60%) and Muhlekwane (50%), over half of households can understand three or more languages.

| Number of Languages | Percentage of Households that can speak number of languages | | |
|---|---|---|---|
| | Gonakudzingwa | Muhlekwane | Malapati |
| 1 | 0 | 15 | 11 |
| 2 | 40 | 35 | **79** |
| 3 | **50** | **41** | 5 |
| 4 | 10 | 9 | 5 |

**Table 1**: Percentage of Households who can understand total number of languages

## 4.3b Summary

Public health communications conducted in **Shangaan** and **Ndebele** will achieve 100% in households throughout the study area. However, households that have only **one primary language** will require special focus, where the use of picture-based communication will be important.

## 4.4 Education

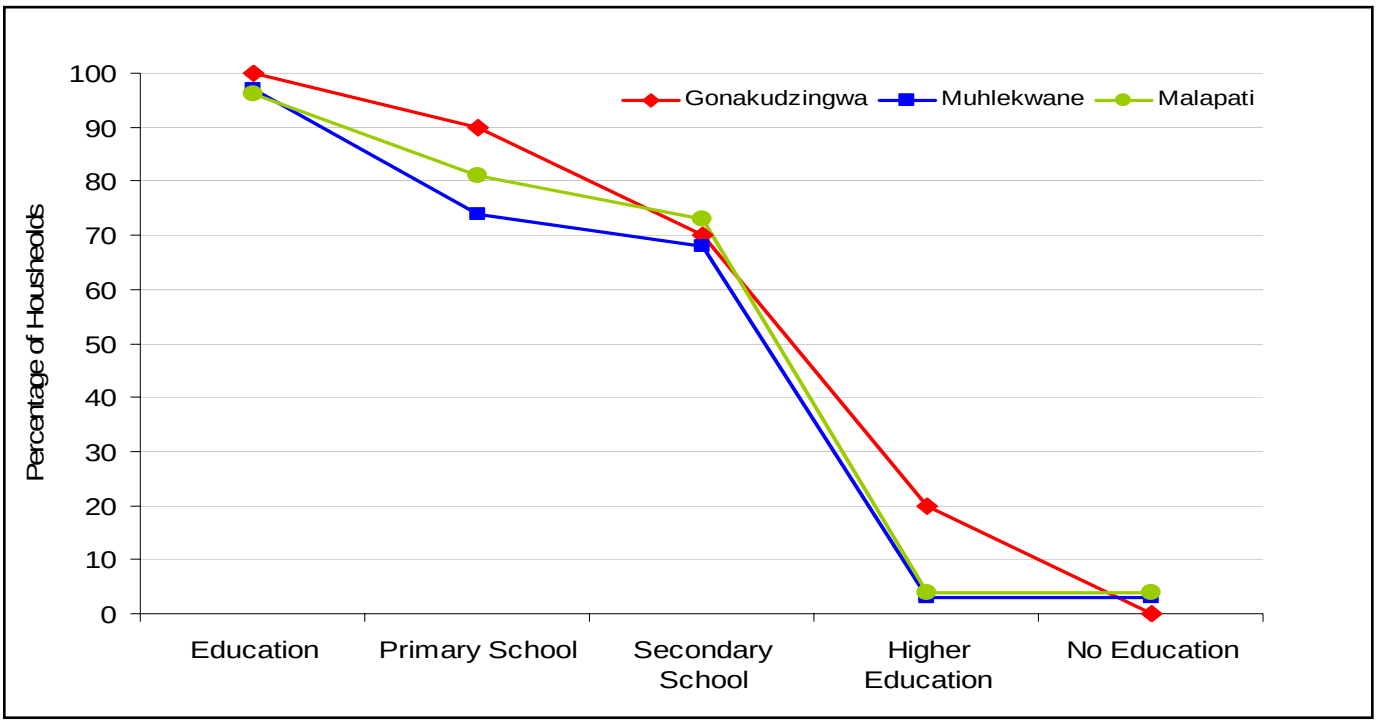
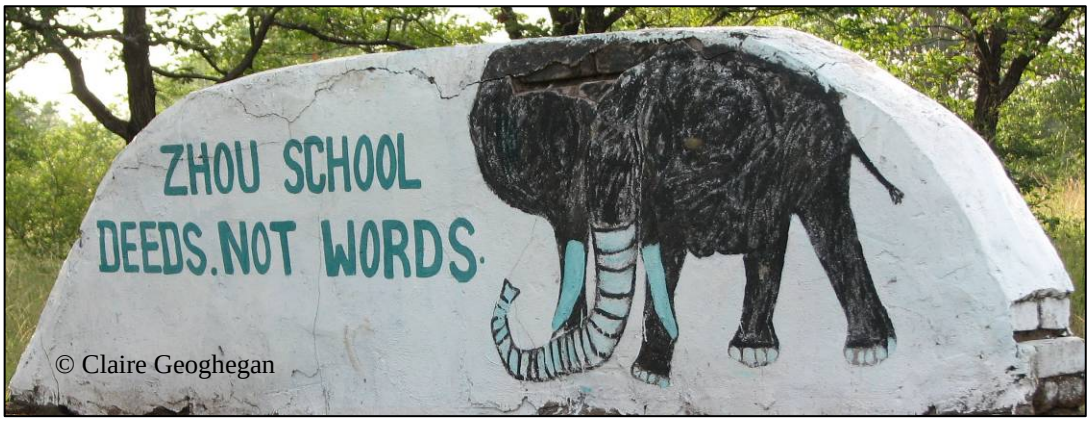



**Figure 5**: Highest Household Education as Percentage of the Total Population, Per Area

School children mostly study at their **nearest** primary and secondary **schools**, with only 3% or primary school children in Muhlekwane, and 20% of primary and 2% of secondary school students in Malapati attending schools in neighbouring areas. Schools therefore present a **good option** for **communicating disease information** to members of households in this area. Unfortunately, high national inflation led to a decrease in school attendance of each of the study sites in 2008, although this began to improve during 2009, with the adoption of foreign currencies in Zimbabwe.

Less than 5% of households in Muhlekwane and Malapati had received no formal education (See Figure 5). Most households report **secondary school** education as their **highest level**, which accounts for 68% of households in each study area. Gonakudzingwa had the highest percentage of households with members in **tertiary education** (20%) which may reflect the greater economic status of households in this commercial farming community.



## 4.5 Household Size and Composition (Obj.2)

Households were analysed with respect to the number and age of inhabitants, classified as the number of people who regularly slept overnight at the household on their property.

Five age group categories are used throughout this study, for ease of comparison and to aid identification of 'at risk' groups with respect to any disease risks identified. The age group classifications used in this project are:

- **Baby** ( 0 – 12 months)
- **Small Children** (13 months – 8 years)
- **Children** (9 – 15 years)
- **Adults** (16 – 59 years)
- **Grandparents** (60 and older)

These age designations are designed to differentiate between the variety of lifestyles and roles in a typical household, which are often defined by and individual's age. For example, it is assumed that small children will have fewer household responsibilities than older children, in a healthy household with good food and financial security. The composition of these age groups within a household will also be used to assess vulnerability to shock, which can be compromised where there are large numbers of dependents and few breadwinners.

Young and elderly individuals will also be generally more susceptible to disease and infection, due to the developing or waning immune systems in these age groups. The ration of these vulnerable groups to adults and older children will be crucial to understanding the full impact of disease risk on typical households in the study areas.

## 4.5a Household Size (Obj.2)

Household size averages between **8 and 14** people across the study region, with a maximum figure of 30 people in one Gonakudzingwa household, which included 22 children younger than 15 years of age (See Table 2).

## 4.5b Household Composition and Resilience (Obj.2, Th.4)

To assess household resilience, we looked at household composition and the span of ages represented in each. Households with fewer age ranges are less resilient to shocks, as they often have fewer income earners, caretakers, and less knowledge of sustainable household and agricultural practices.

In this study, we did not identify any households that were inhabited by either children (younger than 16 years) or grandparents only. However, 2% of households in Malapati were comprised of **children and grandparents only**, which may leave these families vulnerable due to a lack of income, usually earned by adults.

Unusually, 26% of households in Muhlekwane are comprised solely of adults (16-59 years old). This may be due to proximity of work or other social or capital resources, and will require more analysis of household data.

The majority of households in Muhlekwane (65%) and Malapati (68%) did not have grandparents present, which in some areas may reduce the resilience of households that experience shocks to the adult population, either through loss of work or illness. Families with a distribution across all age ranges accounted for 60% of households in Gonakudzingwa, 25% in Malapati and 9% in Muhlekwane (See Figure 6).

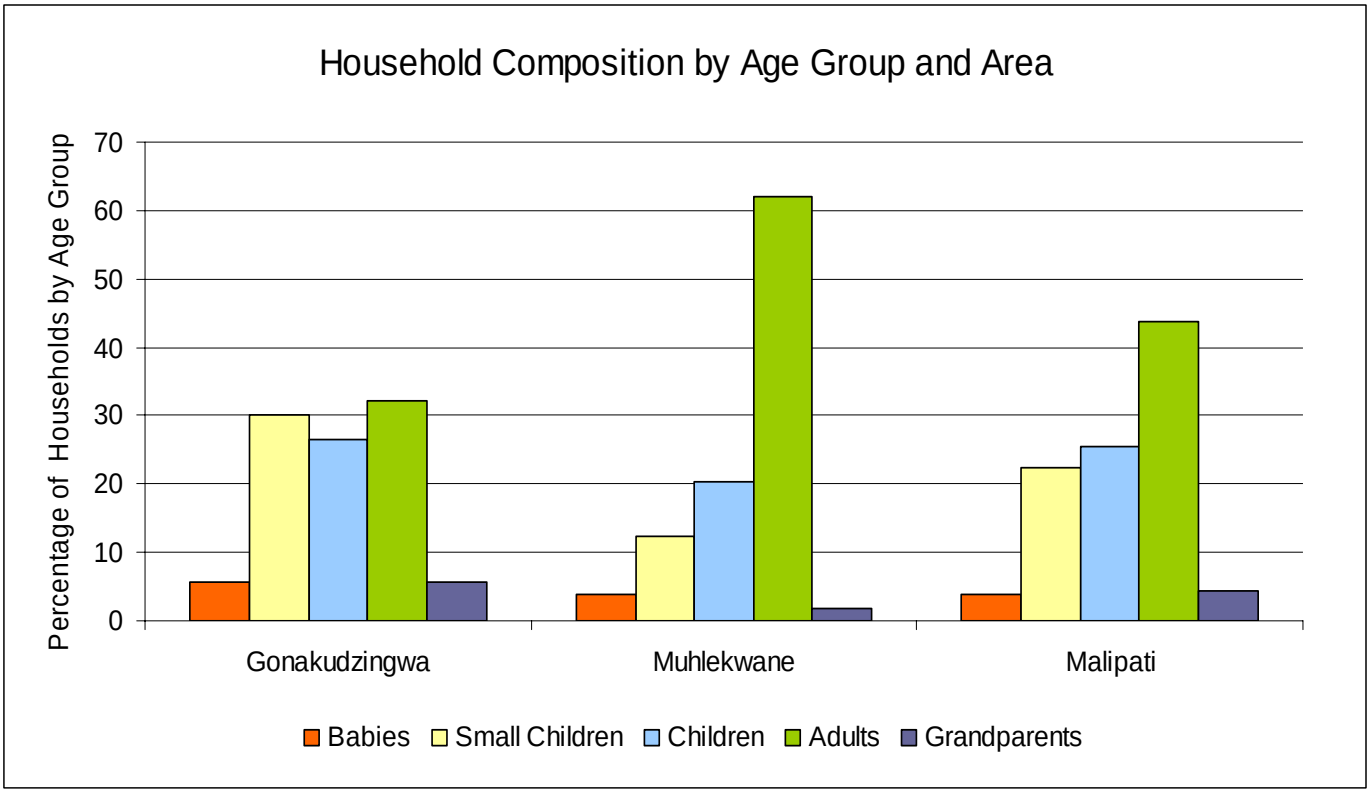



**Figure 6**: Household Composition by Age Group and Area

| Household Composition | Gonakudzingwa | Muhlekwane | Malapati |
|---|---|---|---|
| Average Size | **14** | 9 | 8 |
| Minimum | **6** | 3 | 2 |
| Maximum | **30** | 18 | 18 |
| Children* Only | 0 | 0 | 0 |
| Adults Only | 0 | **26** | 5 |
| Grandparents Only | 0 | 0 | 0 |
| Children* and Adults Only | 40 | 65 | **68** |
| Children* and Grandparents Only | 0 | 0 | **2** |
| Children*, Adults and Grandparents | **60** | 9 | 25 |

**Table 2**: Household Size and Composition, and percentage of households with defined characteristics
* Children refers to any person under 16 years of age

## 4.6 Household Access to Resources (Obj.2, Th.3&4)

These parameters will be used to guide assessments of social capital for each area, and provide information on household access to food, communication, agricultural and transport facilities. Household access to facilities will improve or decline over time, depending on changes to household stability, composition, health and surrounding environmental and political trends. By monitoring these trends, we can provide estimates of household access to financial resources, which are critical for food security, health and education in rural areas.

Knowledge of local resource access can also improve the effectiveness of community outreach and public health programmes, which will be essential when disseminating the results of this research, or other information regarding health and the GLTFCA over a wide area.

In this study, we have divided and assessed the resources available to households across two parameters:

**i.** Material resources (transport, communications, household possessions)

**ii.** Natural and agricultural resources (food, water, grazing lands)

## 4.8 Household Access to Material Resources (Obj.2, Th.3&4)

### 4.8a Electricity

Access to **electrical power is scarce** overall, with availability reported in 6% of households in Muhlekwane, 2% in Malapati and no households in Gonakudzingwa. Where electrical power is accessible, 100% of households use **solar power** to charge batteries within the home. This method of power generation is cheap, but with few schemes to facilitate access, coverage is poor.

## 4.8b Cooking and Food Safety

The use of electric or gas powered ovens or stoves were not reported in any of the study areas. The majority of cooking is done using traditional **wood fires** either within buildings or outside on the household property. This requires use of natural wood resources, and may lead to respiratory illness when conducted in confined areas. The heat generated by this method is less controllable than other food preparation methods, and may have an impact on the quality and safety of food produced.

No households reported using or owning a **fridge** or **freezer**, which reduce the longevity of food in the hot local climates. These aspects of potential pathogen risk will be investigated in more detail via the analysis of household questionnaires over the coming months.

## 4.8c Transport

Transport is vital for the movement of people and animals to health facilities and markets. The most common form of transport in all areas, and most reported household possession, is the **bicycle** (See Figure 7). Although bicycles can not carry large loads or numbers of people, they are easily used by all age groups and require no fuel. As the study areas are flat, and bicycles are relatively cheap to buy and maintain, it is not surprising that **80%** of households in Gonakudzingwa, 43% in Malapati and 41% in Muhlekwane have access to this form of transport.

Only 3% of households in Muhlekwane have access to motorised transport via a car or tractor, but **70%** of households in Gonakudzingwa own a **car,** and 20% own **tractors**, showing the greater economic status of the larger scale commercial farmers in this area.

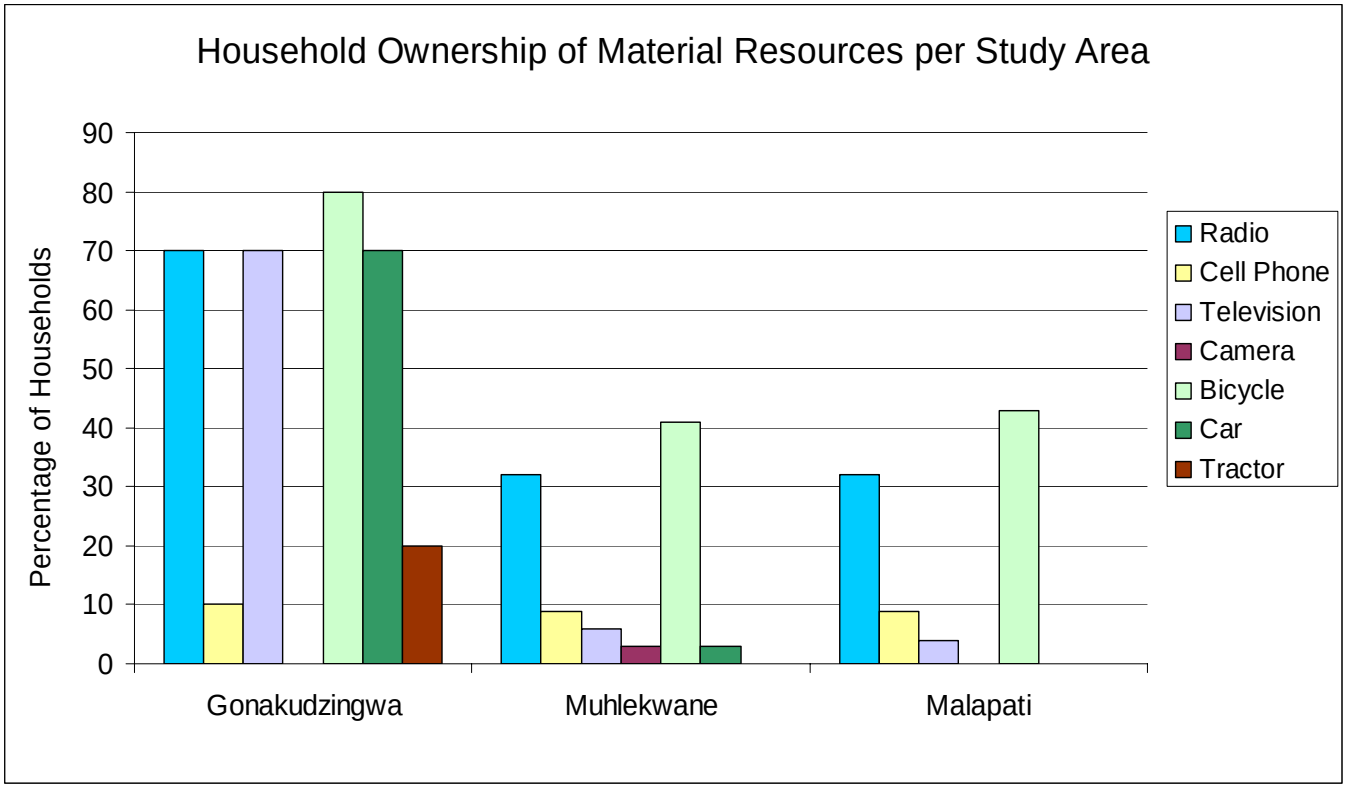



**Figure 7**: Household Ownership of Material Resources per Study Area

## 4.8d Communications and Entertainment

Access to communications is an important indicator of household strength, and increases knowledge and participation in broader social, cultural and political activities. By understanding household access to different forms of communication, community health and conservation messages can be targeted to cover a wide area through the most relevant forms of media for each location. This is more cost effective and hopefully will lead to better information dissemination to local levels.

**Radios** are the most accessible communication resource, with ownership in 70% of households in Gonakudzingwa, and 32% in Muhlekwane and Malapati. Radio's are cheap and have the advantage of operating on small amounts of power, which can be obtained through solar or battery sources.

Few households in Muhlekwane (6%) and Malapati (4%) have access to **televisions**, which are more expensive to buy and power. An indication of the greater economic wealth in Gonakudzingwa is reflected in 70% household ownership of televisions, which may give an advantage to these families, and improve the quality and comprehension of information obtained through visual entertainment.

However, a greater number of people in the community may have access to these resources through the shared use between households and relatives, especially during eventful times, like political and sporting events. These may present a great opportunity to convey public health information and reach a wider audience. Using both radio and television media will provide communication to 90% of households in Gonakudzingwa being contacted, although it does not increase the audience in Muhlekwane or Malapati, which remain at 32%.

**Cellular telephone** use is low throughout the area, with 10% household ownership in Gonakudzingwa, and 9% in Muhlekwane and Malapati. Cell phone communication is restricted by cost of handsets, and electrical requirements needed for recharging handsets. Poor investment by cell phone providers also leaves few areas with network coverage. As national investment begins, it is anticipated that communities in remote areas will be targeted, as they represent an untapped market. If this occurs, opportunities to use SMS services to convey public health information and reminders to patients taking drugs will enhance rural health dramatically, as seen elsewhere in southern Africa.

Currently, cell phone ownership can be used as an **indicator of household wealth**, as 100% of cell phone owning households in Gonakudzingwa also own a radio or television, while only 66% own a radio in Muhlekwane, and 80% in Malapati.

No households described access to **computers**, or internet services. Only 3% of households in Malapati reported access to a **camera**, indicating these items are expensive and a luxury item in these areas.

## 4.9 Household Access to Natural and Agricultural Resources (Obj.1&2, Th.2,3&4)

Access to natural and agricultural resources is important for family health and wellbeing. However, contact with livestock and wildlife, especially near food and water resources, introduces an element of disease risk. To understand the risk of pathogen transfer between and within wildlife, livestock and human populations, we conducted analysis to determine the frequency of contact between these groups, and the health status of each within the GLTFCA.

## 4.9a Livestock Ownership

**Nine livestock species** were reported in each of the three study sites, including three larger species (cattle, goats and sheep), two drought-power species (cattle and donkeys), three types of poultry (chicken, turkey and guinea fowl) and two self-sustaining species (cats and dogs) (See Figure 8)

**Cattle** are owned by **100%** of households in each area, highlighting their value as a source of meat and money, and social status for those intending to get married. **Goats** are similarly popular, being owned in 100% of households in Gonakudzingwa and Malapati, and 97% in Muhlekwane. This hardy species has a high tolerance for poor grazing and water availability, and provides a quick source of income and cheap source of meat.

**Chickens** were the most numerous species owned in Gonakudzingwa and Malapati, and were kept in 100% and 98% of households respectively, and 94% in Muhlekwane.

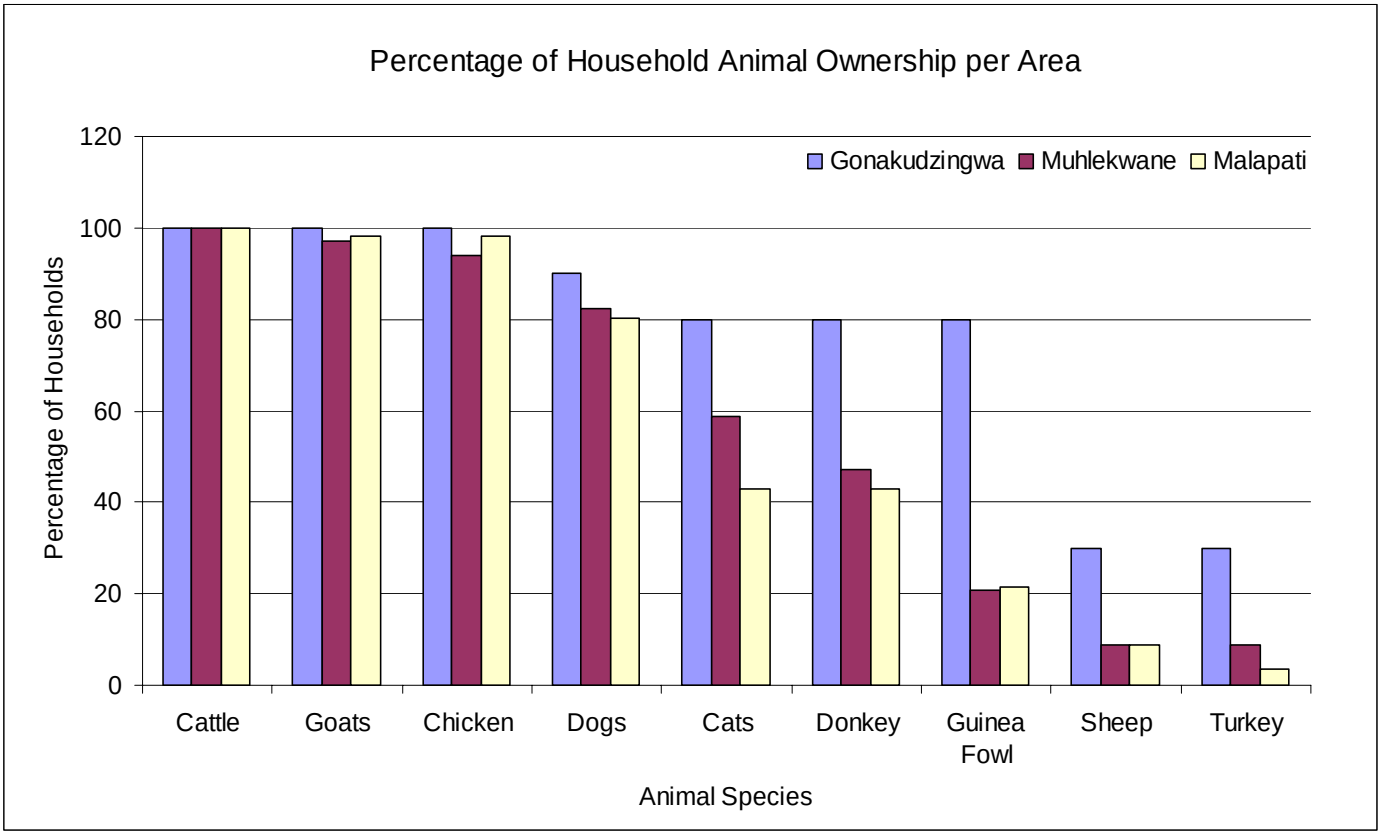



**Figure 8**: Percentage of Livestock Owning Households, per Species and Area

Greater than 80% of households own **dogs,** which are often kept for assistance with small-scale hunting, household security and protection of livestock from predation. High possession of **donkeys** (80% in Gonakudzingwa, 47% Muhlekwane, 43% Malapati) reflects the use of this species for drought power and scotch carts, which provides the majority of load-bearing transport in the area (See photograph on page 28).

## 4.9b Livestock Ownership and Disease Risk (Obj.2,3&4, Th.2,3,4&5)

The **assemblage of livestock species** will influence the diseases that are present, or that may emerge, at household level. For example, high densities of mixed bird species may make households more vulnerable to diseases that can infect one species with few clinical consequences, but may cause high levels of mortality in another. Similarly, overlap between species at risk of disease can make **control and vaccination campaigns** more complicated, as seen with rabies, where due to the nature of each carrier species, dogs are more easily vaccinated than cats. A mixture of traditional livestock and wildlife species (as reported by households keeping Guinea Fowl), may also enhance the potential for newly emerging diseases, of which the great majority are zoonoses.

Preliminary analysis shows that a greater number of households keep chickens and guinea fowl, than other combinations of poultry species. Further analysis of these and other species relationships will enable us to provide estimates of potential disease outbreaks, which can be used by local animal health services to target disease prevention programmes in each study area.

## 4.10 Cattle Ownership and Disease (Obj.1&2, Th.2,3&4)

As many households rely on cattle for **social, cultural, food** and **financial security**, we looked at the composition of cattle herds, stock increases and decreases and illness within each study area.

## 4.10a Cattle Herd Size and Composition

Households in Gonakudzingwa owned an average of 38 cattle, which was significantly greater than the averages in Muhlekwane (11) and Malapati (13). Households in this area also had the highest percentage of adult female animals (64%) in each herd, which reflects the commercial nature of farming in this area (See Figure 9). The highest percentage of adult males was in Muhlekwane (28%), while calves were the greatest percentage in Malapati (23% of herds).

Preliminary analysis shows **no correlation between the size and composition of cattle herds with household size and composition,** for any area or the region as a whole. Further investigation of more detailed household data may yield better insights into the decision making process regarding the type and number of animals owned by a household. This analysis will consider a range of events that may drive the purchase or sale of animals, including cultural transitions that require cattle to be purchased prior to marriage.

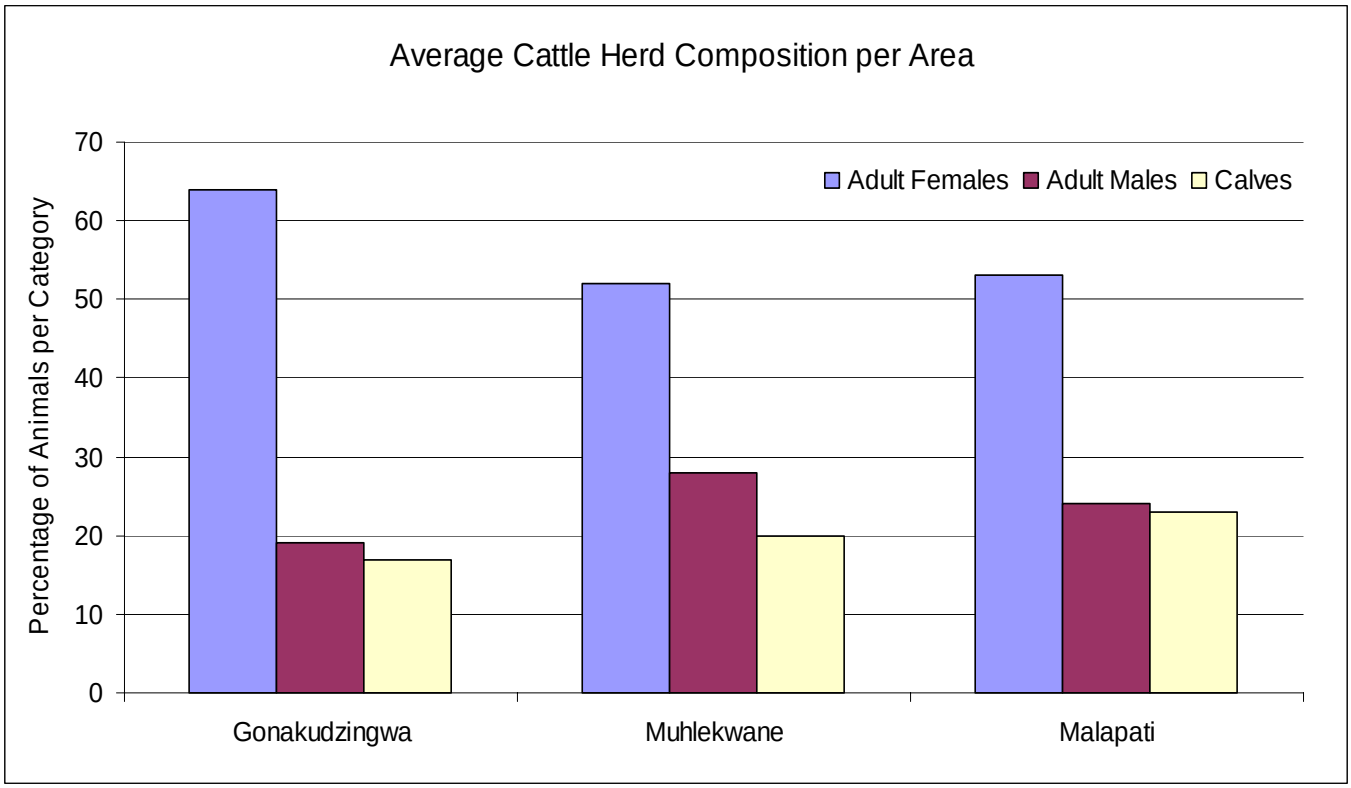



**Figure 9**: Cattle Herd Composition per Study Area

## 4.11 Cattle Mortalities

To assess the level of cattle illness in each study area, we asked farmers to report all cattle mortalities experienced within the previous 12 months. **Fifty percent** of households interviewed across the study area had been affected by cattle mortalities. This places a heavy burden on household finances, and reduces their access to drought power required for agricultural practices, and manure, which is used as a fertilizer and fuel source.

## 4.11a Cattle Mortalities due to Disease (Obj.2&3, Th.2)

**Sixty-nine** percent of cattle deaths were associated with **disease**. Malapati was the most affected, with 74% of mortalities, caused by 3 known, and a number of unknown diseases (See Table 3). Gonakudzingwa suffered most severely with **Heart water** (22% of mortalities), **Foot and Mouth Disease** (22%) and **Lumpy Skin Disease** (11%). **January Disease** was reported as the cause of death for 4% of cattle in Malapati, and **Anthrax** was thought to be the reason for 4% of cattle deaths in Muhlekwane. The majority of these diseases also pose a concern for human health, highlighting the need for greater integration and support between human and animal health service in rural areas.

Noticeably, **50%** of all cattle deaths reported in the area were attributed to **unknown diseases**, accounting for 57% in Malapati, 46% in Muhlekwane and 11% in Gonakudzingwa. As this project deliberately asked farmers to diagnose the causes of death to incorporate local knowledge into this assessment, we are unable to apportion these causes of death to any known illness. The lack of animal health services in these remote areas, coupled with poor transport and communication resources, means that little testing has been possible locally, resulting in a general lack of disease knowledge for these areas.

Commercial farmers displayed a greater **knowledge of disease**. This may be due to the greater economic value placed on cattle health, which can prevent access to markets. The use of commercial abattoirs may also help to inform farmers of diseases detected in their herds, especially if it restricts the sale of their meat. This will be explored further during the analysis of participatory workshops in each area, where farmers discussed the causes, identification and treatment of disease in more detail.

| Disease | Gonakudzingwa | Muhlekwane | Malapati | Area Total |
|---|---|---|---|---|
| Heart water | **22** | - | 10 | 9 |
| Foot and Mouth | **22** | 4 | 1 | 4 |
| Anthrax | - | 4 | - | 1 |
| January Disease | - | - | 4 | 3 |
| Lumpy Skin | 11 | 4 | - | 2 |
| Unknown Disease | 11 | **46** | **57** | **50** |
| Total Mortality | 66 | 58 | 74 | 69 |
| Total Number of Reasons | 4 | 4 | 4 | 6 |

**Table 3**: Percentage of Cattle Mortalities by Disease per Study Area, 2008/09

## 4.11b Cattle Mortalities other than Disease (Th. 2)

**Eight reasons other than disease** were reported as causes of cattle mortality but accounted for less than 31% of deaths overall (See Table 4). Environmental issues accounted for 14% of mortalities in Malapati, where 10% were attributed to a **lack of grazing**, and 4% died while **trapped in mud** (which was the reason for 13% of deaths in Muhlekwane). In both these areas, over 60% of animals use rivers to obtain drinking water, which may account for high levels of entrapment in surrounding areas.

Nine percent of cattle in Malapati died due to being caught in **snares**. It is not clear where the majority of these incidents took place, but the proximity and use of conservation and community lands by cattle for grazing may overlap with bush meat snaring activities. These aspects will require more investigation.

Other symptomatic causes of death were described in Muhlekwane and Malapati, including paralysis and birth complications, which may hint at **undiagnosed disease**. Other farming activities were responsible for mortalities in Muhlekwane, including 8% of mortalities due to poorly administered dehorning.

Loss of cattle through **predation by wildlife** can result in declining support for local conservation areas. In Gonakudzingwa, **33%** of cattle mortalities were due to predation, and accounted for the only non-disease related deaths on these commercial farms. Predation also accounted for 4% of cattle mortalities in Muhlekwane, which is located on a different park and hunting area boundary (See Figure 3). Reports on wildlife sightings (see section 14.5) provide evidence to support these mortality estimates, based on the numbers of predators seen in each study area. It will be prudent for predation to be monitored within the GLTFCA area in order to avoid future conflicts causing problems for the sustainability of the TFCA.

| Other Reasons | Gonakudzingwa | Muhlekwane | Malapati | Area Total |
|---|---|---|---|---|
| Trapped in Mud | - | **13** | 4 | 6 |
| Trapped in Snares | - | - | **9** | 6 |
| Lack of Grazing | - | - | **10** | 7 |
| Paralysis | - | 8 | - | 2 |
| Dehorning | - | 8 | - | 2 |
| Birth Complications | - | 8 | 1 | 3 |
| Broken Leg | - | - | 1 | 1 |
| Predation | **33** | 4 | - | 4 |
| Total Mortality | 33 | 41 | 25 | 31 |
| Total Number of Reasons | 1 | 5 | 5 | 8 |

**Table 4**: Percentage of Cattle Mortalities other than Disease, per Study Area, 2008/09

## 4.12 Spatial aspects of Cattle Disease (Obj.1, Th.2,3&4)

To understand the potential for disease transmission within cattle populations neighbouring Gona-re-Zhou and the GLTFCA, we investigated the role of cattle sales, purchases and gifts on cattle movement within the area.

### 4.12a Stock Increases from Purchases and Gifts

Less than 5% of households bought or were given cattle in the 3 months prior to this study (2% in Gonakudzingwa, 3% in Muhlekwane, and 5% in Malapati). In Gonakudzingwa and Muhlekwane, 100% of purchased animals were from the same area and bought to increase household stock. In Malapati, **86%** of cattle were bought from distances greater than **20km** in order to increase household stock and pay a traditional healer.

The introduction of cattle from outside each area has the potential to introduce diseases to local cattle, and may be one cause for the high levels of mortality due to disease (74%) in Malapati. The 14% of animals that were bought within Malapati were to pay for bride dowries, which is customary throughout southern Africa.

### 4.12b Stock Decreases from Sales and Gifts

**Fifty percent** of households in Gonakudzingwa sold cattle in the 3 months prior to this survey, and were all sold within the local area, minimising risks of disease spread over a wider area. Eighteen percent of households in Muhlekwane, and 20% in Malapati sold cattle in the 3 months prior to the survey, with the majority (57% and 69%) remaining within the same area.

However, **14% of animals in Muhlekwane,** and **8%** in Malapati were **sold** across the international border to **Mozambique**. Of these animals, those from Malapati had experienced delivery problems which may be due to disease; while sales from Muhlekwane were driven by the **need for money to pay hospital fees**, showing the influence of human health needs on cattle movements. These animals were also from a household that reported cattle mortality due to **Anthrax** in the previous 12 months. This highlights the need for good disease testing, education and stock control to prevent the accidental spread of infectious and zoonotic diseases across international boundaries.

**Income generation** was the greatest driver of sales for each area, especially for food (57% in Muhlekwane), school fees (15% Malapati) and hospital fees (14% Muhlekwane). Bride payments and traditional rituals also drove cattle sales in Gonakudzingwa (18%) and Malapati (23%).

Twelve percent of animals sold in Gonakudzingwa were sick or old, and deliberately put on the market, while 16% were experiencing problems giving birth or old in Malapati. This suggests that **animals who are decreasing in value are put on the market before they become worthless**, which in some cases, may increase the potential for disease transfer to other areas.

## 4.12c Cattle Mortality and Movement

Six percent of households in Muhlekwane both bought and sold cattle in the 3 months prior to this study. Participation in purchasing and selling cattle was not reported in either of the other study areas.

In Gonakudzingwa, of the 50% of households affected by cattle mortalities due to predation, **67% were able to replace lost stock** with cattle from the local area. Twenty percent of cattle sold from Gonakudzingwa within the local area came from households who had **e**xperienced mortalities due to **FMD** in the previous 12 months, posing a risk of disease transfer to neighbouring farms.

In Muhlekwane, of the 50% of households who experienced cattle mortalities in the previous 12 months, **6%** bought cattle to increase their stock. Twenty-four percent of households who lost stock due to disease-related mortalities also sold cattle. Half of these were sold locally in order to obtain money for food, but all came from households who were **experiencing unknown diseases**.

Poor environmental conditions caused 10% of mortalities in Malapati, which was a major driver of cattle purchases (67%), all of which came from distances of **more than 30km's**. Cattle purchased from areas greater than **45km's** were bought to pay traditional healers, and introduced into herds that had **experienced mortalities** due to **unknown diseases**.

## 4.13 Summary

Sixty percent of cattle mortalities in these study areas were due to disease, with the great majority associated with zoonotic pathogens. The movement of cattle through sales, gifts and purchases increases the potential for disease spread between herds and communities. The most serious scenario is the sale of cattle across international boundaries from households that have experience mortalities due to infectious diseases such as Anthrax within the preceding 12 months. Greater controls on cattle movements, and testing schemes at local diptanks will be needed to help control the spread of disease. This will be particularly important for FMD and other diseases that can restrict international trade of meat products. Until greater control measures area introduced, **the capacity for disease transmission through community livestock populations within the GLTFCA remains high**.

As 50% of households have experienced cattle mortalities within the last 12 months, minimising deaths due to disease and predation will **improve household food and financial security**, with associated benefits for sustainable natural resource use. However, if predation is allowed to continue, the increasing conflict between communities and wildlife will **reduce local support for conservation initiatives** and the GLTFCA.

**Case Study 1**: Field Abattoir, Malapati, Zimbabwe, March, 2009

*Clockwise from Bottom Left:* Farmer and his cow that died of unknown causes near the river; farmer and friends begin the post-mortem with the local animal health technician; removal of the ribcage; the farmer's dog eats the unborn foetus; spreading of the gall bile on the post-mortem site; lung examined for bovine tuberculosis; the animal health technician inspects the gall bladder, determining the cause of death
(All pictures by C. Geoghegan)

## 4.14 Disease Transmission Potential between Wildlife and Livestock (Obj.1, Th.2,3&4)

As many of the cattle diseases mentioned by participants can be transmitted between livestock and wildlife, we assessed the potential disease risk to both groups based upon their frequency of contact at three locations: the household, water points and grazing areas.

## 4.15 Wildlife Sightings and Potential Contact

**Sixteen wildlife species** were reported by farmers across the area, with the greatest diversity seen in Malapati (14 species) (See Table 5). Of all wildlife sightings, 51% were small mammal species, 39% large herbivores, including buffalo and elephant, and 19% were carnivores. The majority of wildlife sightings occurred on **grazing lands** (46%), with 28% taking place at water points, and 26% at households.

Although **Gonakudzingwa** is the study area furthest from the tri-nation border, it has the highest potential contact with wildlife (See Figure 10). **100%** of households reported seeing wildlife, with the majority (74%) split equally between the home and grazing areas, and consisting of large mammal species including **lion** (60% of households) **elephants** (30%) and **buffalo** (20%), **impala** (80% of sightings), **kudu** and other small antelope species.

As 60% of lion, and 75% of elephant sighting occur at home, it is hard for these households to avoid wildlife contact. Conflict with these species due to the perceived or actual loss of crop and livestock resources, will reduce local support for park and conservation programmes requires careful management. Farmers in this area report 33% of cattle mortalities due to **predation**, making the presence of **lion**, **hyaena** and **wild dog** on their property a concern for their families and wildlife conservation.

Transmission of disease between wildlife and livestock may be possible in this area, as the majority of buffalo, impala and antelope contact occurs in grazing areas. With these wildlife species known to be carriers of **exotic pathogens** like bovine tuberculosis elsewhere in the GLTFCA, contact between these groups may need to be restricted where possible, or closely monitored through improved and frequent animal testing programmes.

Residents of Muhlekwane have the least contact with wildlife, with 68% of households seeing wildlife mainly on grazing lands. These account for the majority of buffalo (77%) and elephant (74%) sightings in the area. Although there were no reports of cattle predation, Muhlekwane reports the greatest number of **carnivore species**, and are the only area to see **leopards,** which are reported along with lions and hyaenas at water points.

All wild dog and 67% of hyaena sightings occur at the home, where both species may have the ability to remove smaller livestock species if given the opportunity. A number of smaller mammal species are reported for this area, but the potential for contact between **buffalo** and **livestock** on grazing lands is the greatest risk of disease.

Malapati hosts the greatest diversity of wildlife species, which are seen by 75% of the households in the area. This is probably due to the close proximity of this study site to Gona-re-Zhou national park, and the Sengwe hunting area. Overlap between community grazing and park water sources provides opportunities for wildlife and livestock contact, as evidenced by 68% and 57% of reported wildlife sightings respectively.

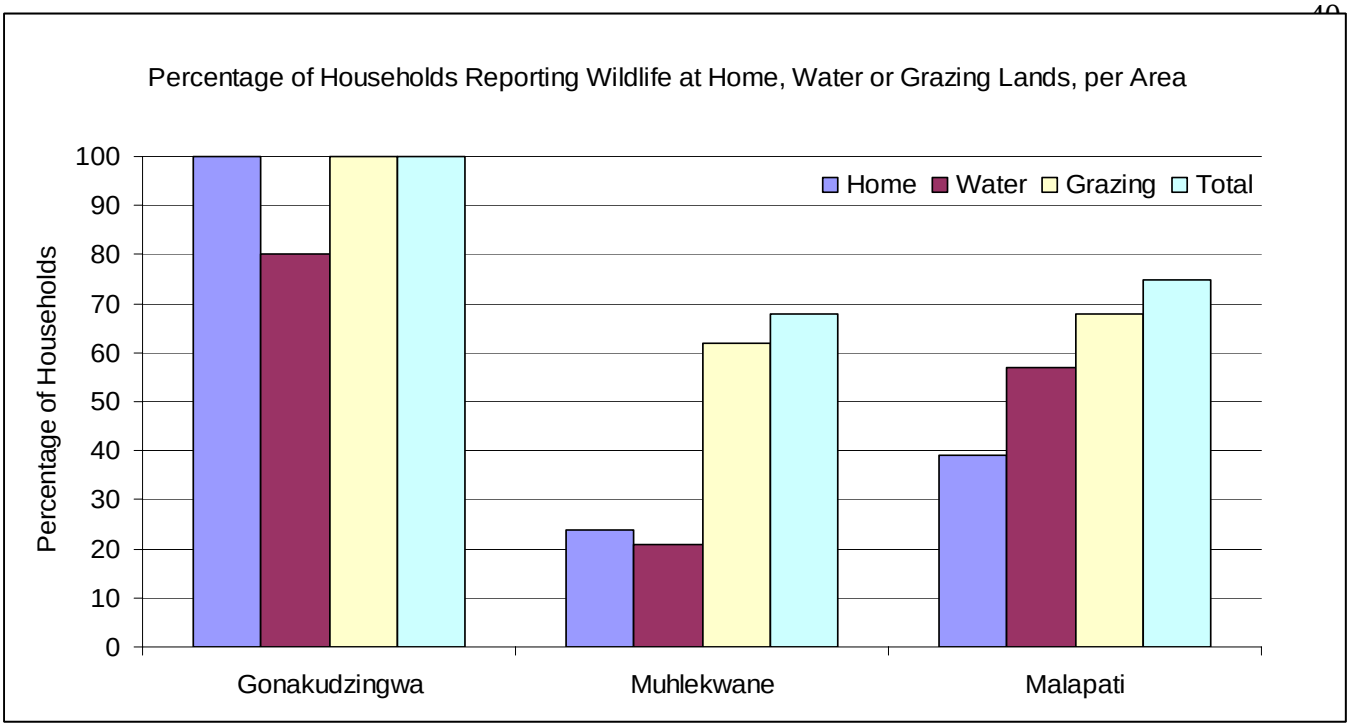



**Figure 10**: Percentage of Households Reporting Wildlife at Home, Water Points and Grazing Lands, per Area

| Wildlife Species | Percentage of Sightings per Wildlife Species per Study Area | | | |
|---|---|---|---|---|
| | Gonakudzingwa | Muhlekwane | Malapati | All sites |
| Antelope | 22 | - | 3 | 6 |
| Baboon | - | - | 6 | 3 |
| Buffalo | 6 | **37** | **17** | **20** |
| Bushbuck | 4 | 5 | 10 | 8 |
| Crocodile | - | - | 3 | 2 |
| Elephant | 7 | **32** | **18** | **19** |
| Guinea Fowl | - | - | 1 | 1 |
| Hyaena | 4 | 10 | 9 | 8 |
| Impala | **33** | 7 | 18 | 19 |
| Kudu | 2 | - | 3 | 2 |
| Leopard | - | 2 | - | 2 |
| Lion | **19** | 3 | - | 5 |
| Monkey | - | - | 2 | 1 |
| Rabbit | - | 2 | 9 | 5 |
| Snake | - | - | 1 | 1 |
| Wild Dog | 4 | 2 | 1 | 2 |
| Total Number of Species | 9 | 9 | 14 | 16 |

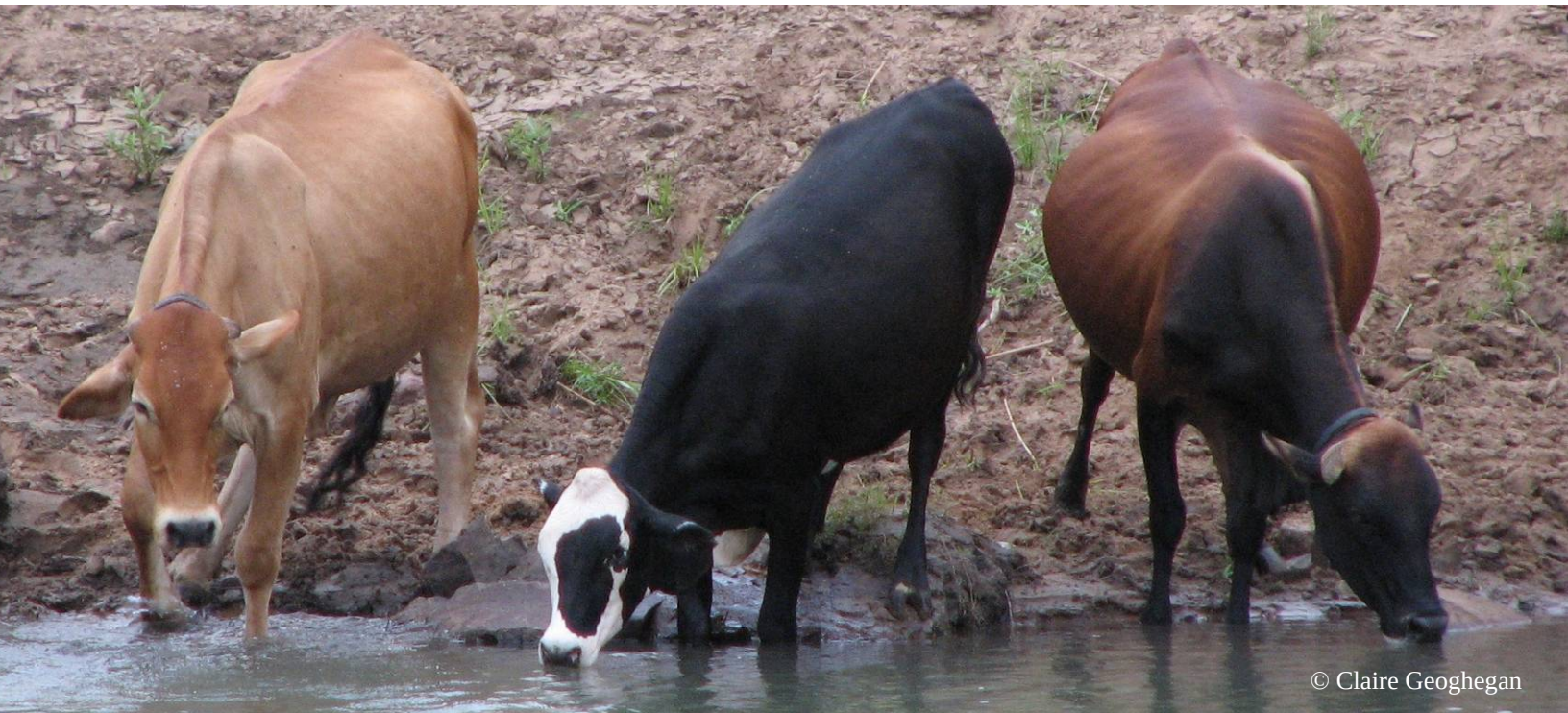
**Table 5**: Percentage of Wildlife Sightings per Study Area

**Impala** are the most widely reported species (by 38% of households), along with **buffalo** (30%) and **elephant** (29%). Although the majority of buffalo (63%) and elephant (40%) sightings take place on grazing lands, the nearby **Mwenezi River** attracts species including 52% of impala, 36% of elephant, and 29% of buffalo, **bushbuck** and **crocodile** sightings. Few carnivores are seen in this area, with the majority of sightings comprising of hyaena (92%) and wild dog, which are mostly seen at home. Other potential disease risks arise from 63% of **baboon** and **monkey** sightings at the household, who may have direct contact with household members while searching for food at the home or in the fields.

## 4.16 Summary

The potential for **livestock and wildlife to use the same land and water resources** has been demonstrated in all three study sites. The ability for wildlife to exit park lands in search of food, prey and water; and for people to herd cattle to park land and water resources creates a complex network of disease potential, either directly through host species contact, or via intermediate hosts (usually smaller mammals) and environmental contamination.

The potential for **conflict between wildlife and people** is also evident and will need to be managed sensitively in order that negative outcomes (predation, loss of crops and competition for grazing lands) do not impinge on support for park and conservation programme. As the southern sections of Gona-re-Zhou remain open and disturbed by people and animals, it is likely that the high level of predator and large mammal contact in the northern study area of Gonakudzingwa will continue, as wildlife species move to less disturbed areas. These patterns of land use will require greater monitoring, as will the introduction and spread of diseases through greater testing and surveillance programmes both in the wildlife and livestock populations within the GLTFCA.



## 4.17 Disease Transmission Potential between Livestock and People (Obj.1, Th.2,3&4)

As 100% of households interviewed in this study owned cattle, and a variety of other livestock species, to understand the potential for zoonotic disease transmission between livestock and people, we investigated scenarios that present opportunities for human infection through direct contact with animals (home, grazing and milking) the environment (water) and bacteria (food).

As **direct contact** between household members and animals will be the primary risk of zoonotic disease transmission, we collected information on the frequency of contact between people and livestock species due to lifestyle and livelihood practices. This fine scale data will provide information on disease risk with respect to household roles in agriculture, food production and age. More detailed analysis will take place over the coming months on this large volume of information. Preliminary results are reported below.

## 4.18 Potential for Environmental Transmission of Disease (Obj.1, Th.2,3&4)

### 4.18a Water

Water is a key resource for all households, people, animals and wildlife, which drives behaviour and patterns of land use for each group. To assess the potential for environmental disease transmission, we examined the relationship between human and animal water use for each area.

As no communal taps, pumps or rainwater drums were reported in any area, the majority of drinking water for animals and humans comes from 5 resource types; household tap, borehole, well, river and dam (See Figure 11).

Residents in Malapati use five types of water resource, with the majority using boreholes (51%) and rivers (39%). Of these resources, 82% of borehole water was used by people, and 93% of river water by animals.

Residents in Muhlekwane relied upon three main water resources, with the majority coming from rivers (60%) and boreholes (31%). Fifty-six percent of river water, and all dam water was used by animals, and 62% of borehole water was consumed by people.

As residents in Gonakudzingwa live furthest from river systems, households in this area mostly obtained drinking water from boreholes (80%) and wells (20%). This water was shared equally between humans and animals in all households, although these closed water systems may represent a reduced risk of pathogen transfer.

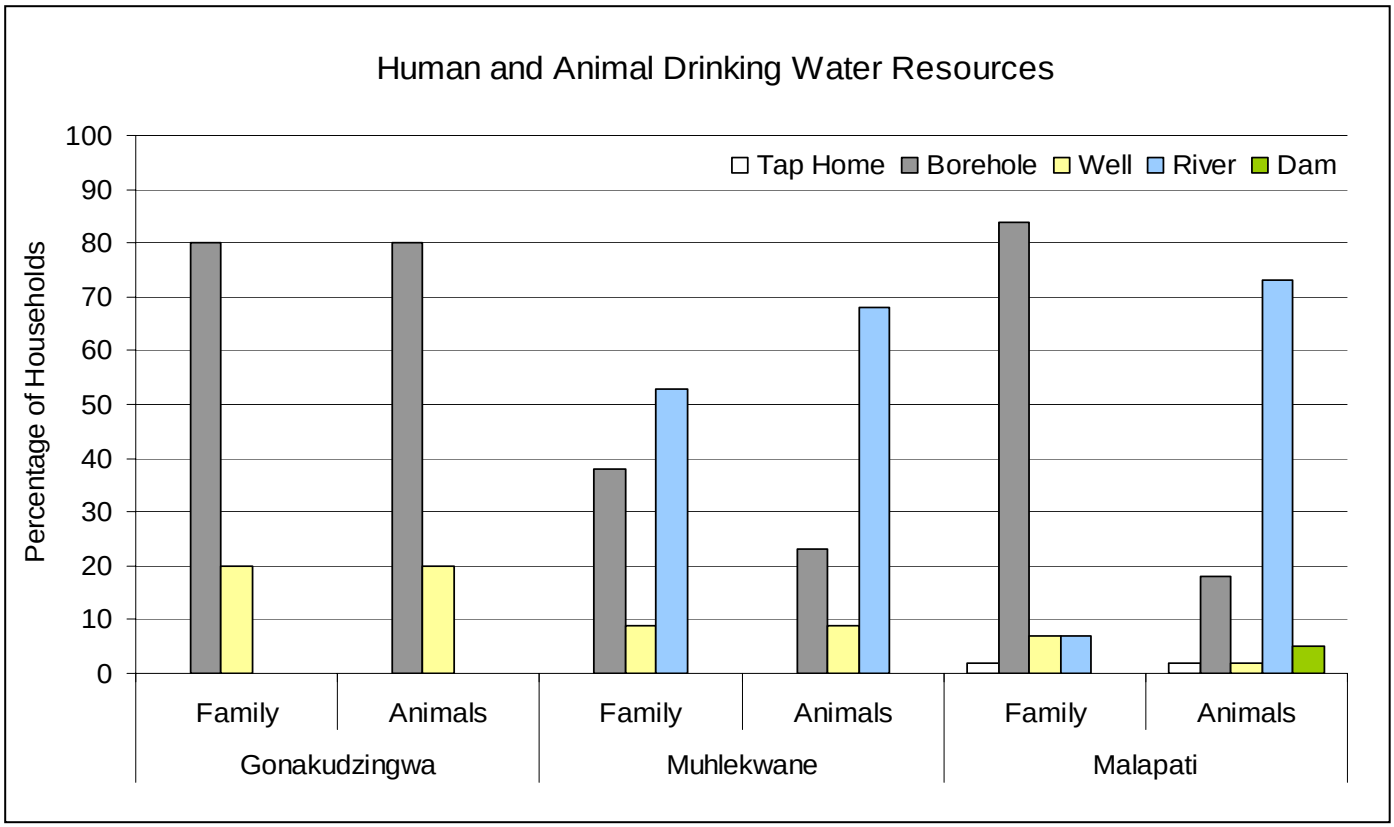



**Figure 11**: Human and Animal Drinking Water Resources

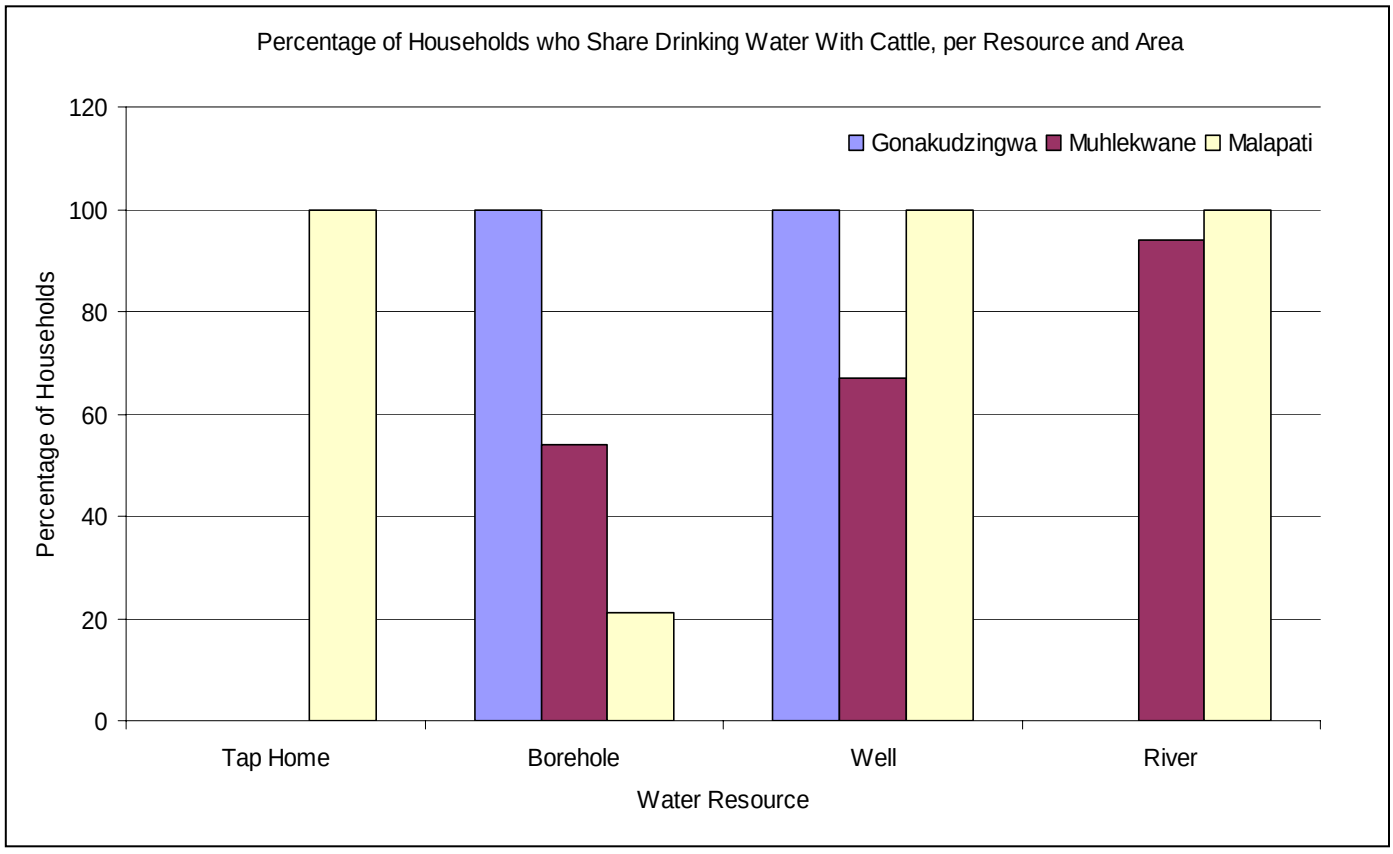



**Figure 12**: Percentage of Households Who Share Drinking Water with Cattle, per Resource and Area

## 4.18b Disease Transmission and Shared Water Resources (Obj.1, Th.2,3&4)

To assess the risk of pathogen transfer between people and animals, we looked at the number of households who share water resources with animals, for each type of water resource (See Figure 12).

Covered water supplies (taps, boreholes and wells) prevent simultaneous use by people and animals, as the water must be transferred from the source to containers before consumption. This reduces the risk of pathogen transmission between people and animals if separate containers are used. However, it will increase the risk of disease to both groups if the water is contaminated at the source.

Households who rely on borehole or well water for household drinking supplies share this with animals mostly when river, dam or other standing water is not available. . As there are no open water sources available in Gonakudzingwa, all households share borehole and well water resources with animals. In Muhlekwane, 54% of borehole users share borehole water and 67% share well water with cattle. In Malapati, fewer families share borehole water with livestock (21%) due to the close proximity of the **Mwenezi River** which is used to supply animal drinking water.

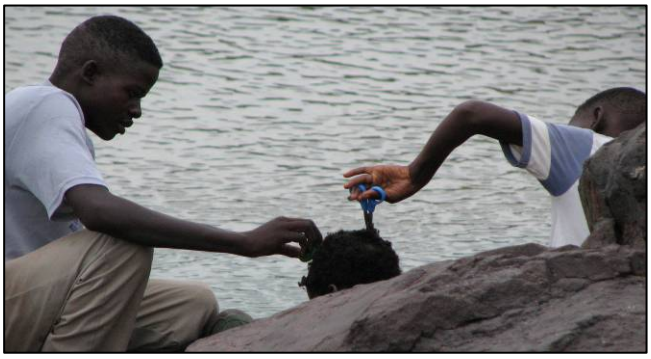
For households that do not have access to closed water supplies, human and animal drinking resources are often shared. Households that rely on **rivers** to provide **drinking water** for people mostly share these resources with cattle (96% in Muhlekwane, and 100% in Malapati). Many of these rivers are used for a range of activities, including clothes washing, bathing and fishing, and may also be used by **wildlife**, which introduces more disease risks.

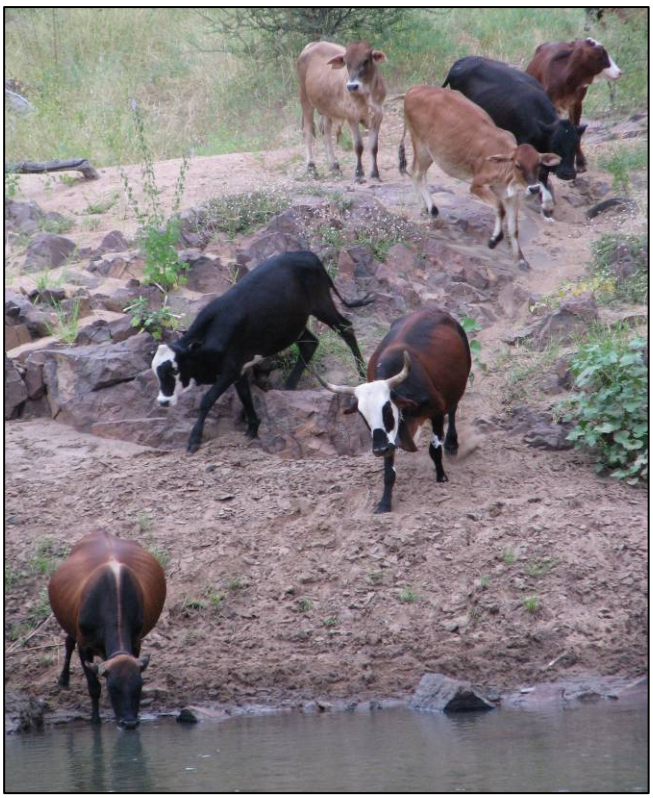
When river water resources have many access points and are in flow, the likelihood of pathogen transmission between species is small, as any contaminating materials will usually be diluted and removed through the system. Where few access points are available, or the river systems are restricted by drought or sedimentation, the density of users and stagnant nature of the water will enhance pathogen build-up and transfer around muddy banks and smaller pools. This may be the reason that households who report use of dam water for livestock use other resources for people. Thus, where alternative drinking water resources are available, it is unlikely that people will choose to share non-flowing open water sources with animals.

More information regarding the frequency of water use by age group, and for different activities is contained within the household data, and will be analysed in due course. This preliminary analysis suggests that **disease transmission between livestock and people can occur at water resources**, especially where households have restricted access to closed and private water resources.

**Case Study 2**: Water Use on the Mwenezi River, Zimbabwe, March 2009

*Clockwise from Top Left*: Cows drinking; Asking livestock owners some questions; Children swimming, Using water to help cut hair; Cows coming down to the river to drink; Cows crossing the river, while a woman and child collect drinking water; Men fishing. (All pictures by C. Geoghegan )





## 4.19 Potential for Food-borne Zoonotic Disease (Obj.1&3, Th.2,3&4)

Access to commercially and locally grown food is difficult for many households within the study areas. As markets are located in larger towns, large distances and lack of transport prevent frequent access. Declining financial stability and high inflation in Zimbabwe before and during this project has further hindered access to food, with shops running out of stock and prices becoming incalculably high.

Many household rely solely on **home grown** and **animal-derived** foods for their diet, which includes fruit, vegetables, grains, meat, eggs, milk and soured dairy products. As local climate variations and droughts affect crops within the GLTFCA area, animal-derived products provide important sources of protein, vitamins and micro-nutrients that are essential for growth, immune system function and general wellbeing.

A consistent and nutritious diet is particularly important for age groups (small children, grandparents) and persons with **compromised immune systems**, especially those who are taking highly toxic medication for TB and HIV/AIDS and other chronic illnesses. Poor access to staple food groups reduces the effectiveness of these drugs, and also leads to malnutrition and fatigue in household members. This compromises the ability for household members to perform daily food and natural resource collecting activities that are essential for household health, leading to a cycle of poor nutrition and wellbeing.

National and international food safety laws are designed to eliminate pathogen spread and transmission through treatment of dairy products, and carcass inspections. These laws are not applied or applicable in areas with poor access to abattoirs and commercial market systems. Local and traditional knowledge is often the only information guiding the production of food for families and small-scale markets, and ultimately the prevention of food-borne disease.

To assess the potential for disease transmission via food, we collected data on the frequency and preparation of three commonly produced animal-derived products: milk, soured milk and meat. Here we present the preliminary results for each area, with more detailed household analysis to follow.

## 4.20 Milk and Soured Milk Products (Obj.1&3, Th.2,3&4)

To assess the potential risk of disease transmission from animals through milk, we assessed the frequency of milk use in households across the three study areas. This was further analysed with respect to age (as some groups are more vulnerable to disease), and milk preparation techniques that may help to prevent disease transmission, such as boiling prior to consumption.

### 4.20a Milk Use per Area

Milk was reported as part of the household diet in all three study areas, and is used most in Muhlekwane (65%) and Malapati (52%). Only 40% of households in Gonakudzingwa reported using milk, which is surprising as this area has the greatest proportion of female cattle and fewest number of calves.

### 4.20b Frequency of Milk Use

The risk of pathogen infection rises with repeated contact with infectious sources. Assessing the frequency of milk use therefore provides information on actual disease risks for households in each area.

Although Gonakudzingwa reported the smallest percentage of household use for any of the study populations; households that use milk, do so at a high frequency. With 78% of households drinking milk daily, and 22% twice per week; milk users in this community have a **high potential for exposure to milk-borne disease** (See Figure 13).

Despite Muhlekwane households reporting the greatest milk use overall, they do so with the least frequency of any study area. Only 35% of households drink milk daily, with the greatest majority using milk twice weekly (62%) or less often (3%). The potential for disease risk through frequency of exposure to milk-borne pathogens is **less than initially suggested** by household milk use figures.

Milk use in Malapati households is evenly spread between daily (44%) and twice-weekly (48%) use. However, the remaining population use milk the least often of any area, with weekly (6%) and monthly (2%) frequencies reported. Disease risk within this area is therefore split between high and low levels of exposure to milk-borne pathogens within the population.

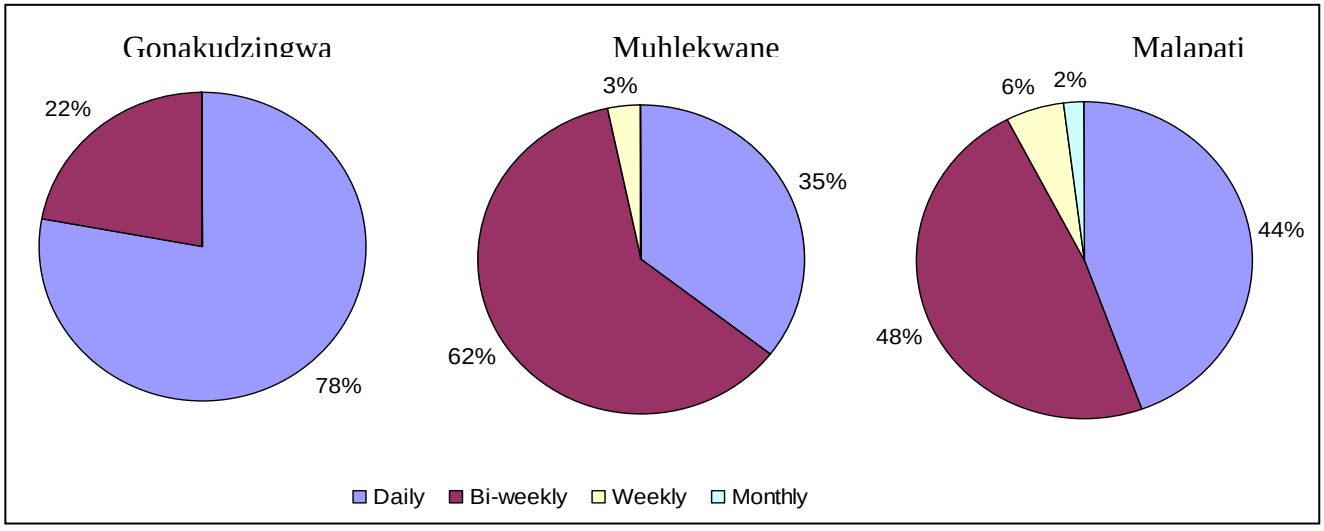



**Figure 13**: Frequency of Household Milk Use, per Area

## 4.20c Milk Use Frequency with Respect to Age

Younger and older people are generally more susceptible to disease. So, to determine the levels of risk within milk consuming households, we assessed milk use with respect to age.

Although 54% of **babies** live in milk using households overall, relatively few use milk in Gonakudzingwa (0%) and Muhlekwane (20%), with more reported in Malapati (62%). However, babies that use milk do so on a **daily basis** in Muhlekwane (100%), with equally high frequencies in Malapati (75% daily, 25% bi-weekly), placing this age group at **high risk** of pathogen exposure.

**Small children** (1 – 8 years) are vulnerable to disease due to their developing immune systems, but they also require micro-nutrients found in milk for growth. Fifty-one percent of small children live in milk using households, with over 88% consuming milk when it is available. As 95% drink milk on a **daily** or **bi-weekly** frequency, this group is at risk of exposure to disease in all study areas.

**Children** (9 – 15 years) have the lowest milk use of all age groups in Muhlekwane, with fewer than 40% drinking milk when available (See Table 7). Children who use milk all consume it on a **daily** or **biweekly** basis, placing users at a greater frequency of exposure than small children in Muhlekwane and Malapati (See Table 6).

Thus, **children in all age** groups under the age of 16 are at **high risk** of milk-borne disease, which should be factored into local public and veterinary health education programmes in all study areas.

| Study Area | Frequency of Milk Use | Baby (0 - 12 months) | Small Children (1 – 8 years) | Children (9 – 15 years) | Adults (16 – 59 years) | Grandparents (60 and older) |
|---|---|---|---|---|---|---|
| Gonakudzingwa | Daily | - | **75** | **67** | **100** | **100** |
| | Bi-weekly | - | 25 | 33 | - | - |
| | Weekly | - | - | - | - | - |
| | Monthly | - | - | - | - | - |
| Average Milk Use per Week (days) | | 0 | 5 .5 | 4.3 | **7** | **7** |
| Muhlekwane | Daily | **100** | 50 | 50 | 20 | - |
| | Bi-weekly | - | 50 | 50 | **73** | **100** |
| | Weekly | - | - | - | 7 | - |
| | Monthly | - | - | - | - | - |
| Average Milk Use per Week (days) | | **7** | 5.4 | **6.1** | 3.9 | 3.5 |
| Malapati | Daily | **75** | 38 | 46 | 41 | - |
| | Bi-weekly | 25 | 46 | 54 | 47 | **100** |
| | Weekly | - | 15 | - | 6 | - |
| | Monthly | - | - | - | 6 | - |
| Average Milk Use per Week (days) | | **6.1** | 3.7 | 5.5 | 4.6 | 3.5 |

**Table 6**: Frequency of Milk Use per Study Area and Age Group

Milk use by adults and grandparents varies across study areas, and may reflect household preference for consumption by children when quantities are limited. Overall, seventy-nine percent of **Grandparents** (aged 60+) use milk when available, mostly at a bi-weekly frequency. However, grandparents and adults located in Gonakudzingwa all drink milk on a daily basis, which may indicate the increased productivity of commercial cattle herds in this area.

**Adults** (16 – 59 years) consume milk least frequently overall, with the majority of those in Muhlekwane and Malapati averaging twice-weekly use or less. Consumption is least in Malapati, where 6% of adults drink milk on a monthly basis. With low frequency of use, and only 28% of all adults consuming milk, this group is at **least risk** from milk-borne diseases overall.

This data highlights the need to quantify the **frequency of food use** in order to correctly assess the risk of disease. Public health programmes can use this information to target 'at risk' populations based on the overall household milk use per area, and the age groups of most frequent users. The most effective programmes will monitor changes in food availability and milk use across age groups, as this may be influenced by larger political and social changes in Zimbabwe.

| Study Area | Age Group | Percent of total population who live in milk using households | Percentage of household members who use milk | Percentage of total population who drink milk | Potential milk use increase (of total population) |
|---|---|---|---|---|---|
| Gonakudzingwa | Baby | **50** | - | - | **100** |
| | Small Children | 42 | **100** | 42 | 58 |
| | Children | 47 | **100** | 47 | 53 |
| | Adult | 41 | 11 | **4** | **96** |
| | Grandparents | 38 | 67 | 25 | 75 |
| Muhlekwane | Baby | **91** | 20 | 18 | **82** |
| | Small Children | 58 | **90** | 53 | 47 |
| | Children | 48 | 38 | 18 | **82** |
| | Adult | **71** | **75** | 53 | 47 |
| | Grandparents | 60 | **100** | **60** | 40 |
| Malapati | Baby | **81** | 62 | 50 | 50 |
| | Small Children | 53 | **88** | 46 | 54 |
| | Children | 61 | 62 | 38 | 63 |
| | Adult | 52 | 50 | 26 | **74** |
| | Grandparents | 39 | **71** | 28 | **72** |
| Area Averages | Gonakudzingwa | 43 | 65 | 28 | 72 |
| | Muhlekwane | **65** | **69** | **45** | 55 |
| | Malapati | 55 | 63 | 35 | 65 |

**Table 7**: Milk Use as a Percentage of Household and Area Populations

## 4.20d Raw Milk Consumption (Obj.1&3, Th.2,3&4)

Although the frequency of exposure to pathogens is a determinate of disease risk, household practices and food preparation techniques can reduce this risk by killing bacteria. We tested the disease risk and awareness of households by assessing milk preparation practices. Knowledge of food preparation preferences can be factored in to disease risk profiles and used to guide public health programmes for each area.

**Consumption of raw milk is common throughout the area**, as reported by 50% of households in Gonakudzingwa and Muhlekwane, and 31% of households in Malapati. This represents 80%, 58% and 31% of milk drinkers in each area respectively, showing a high degree of pathogen risk in Gonakudzingwa.

Less than 50% of the total population in each study drink untreated milk. However, within milk users, the percentages are often higher, with specific age groups being at greatest risk within each study area. (See Figure 14).

Although grandparents represent up to 60% of all milk drinkers, no consumption of raw untreated milk was reported by this age group. This may hint at a greater perception of disease within this population. Raw milk consumption occurred across all other age groups in Malapati, accounting for at least 20% of milk consumed in each.

High volumes of milk consumed in Muhlekwane by adults (65%) and small children (58%) is raw and untreated, although 92% of milk consumed by children has been boiled prior to consumption.

In Gonakudzingwa, all raw milk is consumed by **small children** (83%) **and children** (94% of users), which reflects the minimal use in other age groups in this area, but places these vulnerable age groups at **high risk**.

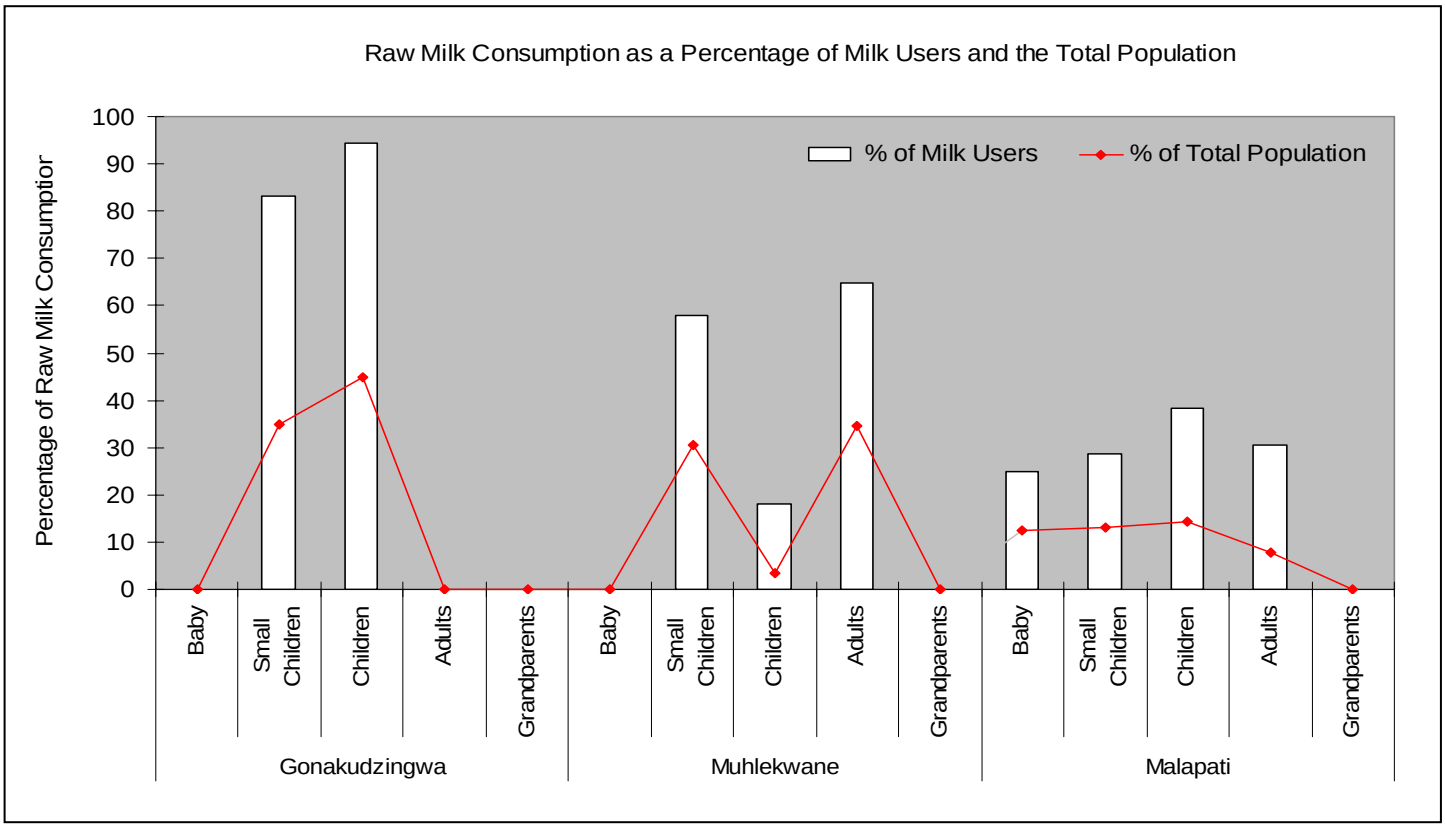



**Figure 14**: Raw Milk Consumption as a Percentage of Milk Users, and Total Population

## 4.20e Disease Risk Awareness and Milk Pasteurisation (Obj.1&3, Th.2)

Understanding the reasons for pre-treatment of milk prior to consumption can be used to tailor public health programmes to local behaviours, and increase the relevance of public health projects.

Over 50% of households that boil milk prior to consumption, reported doing so to **enhance the taste**, rather than for food hygiene reasons. Although no other reasons were mentioned in Gonakudzingwa, 46% of households in Muhlekwane, and 35% in Malapati reported a desire to '**kill bacteria or germs**' as a reason for boiling milk before consumption.

This low level of disease awareness can be improved by the inclusion of milk hygiene practices in public and veterinary health programmes. This is particularly necessary in Gonakudzingwa, where no disease awareness was exhibited, but the greatest percentage of small children and children drink milk.

With a large potential rise in milk consumption possible in each study area, it will be important to prevent unnecessary disease transmission by **increasing awareness of milk-borne illness in communities throughout the GLTFCA**.

## 4.21 Soured Milk Products and Disease (Obj.1&3, Th.2,3&4)

Soured milk, or '*Kukora*' is a commonly used in rural African communities, where the lack of electricity and refrigeration prevents the preservation of fresh milk. In the study area, it is made in a '*Hwedza*' or clay pot, by adding fresh milk to previously soured milk to form a thicker dairy product through bacterial growth. In some households, hwedza are kept close to indoor fires where heat hastens the souring process. Little information is available on the longevity of many zoonotic pathogens within kukora, although it is generally assumed that the increasingly acidic content of the soured milk will eventually kill the bacteria. As kukora production varies between households according to taste and consumption preferences, we included this product as a practical risk factor for disease transmission in this study.

### 4.21a Soured Milk Use per Area

**Soured milk is used by a larger percentage of households than fresh milk**. This is especially noticeable in Gonakudzingwa, where twice as many households (80%) use kukora compared to milk. This may be due to the larger milk yield derived from commercial herds in this area, and few electrical and refrigeration facilities to keep the milk fresh. Kukora is also used in Muhlekwane (84%) and Malapati (72%) households.

### 4.21b Frequency of Soured Milk Use

Figure ** shows that the majority of households in all study areas use soured milk on a **daily basis**, ranging from 38% in Malapati to 83% in Gonakudzingwa. As reported for milk, all households in Gonakudzingwa use kukora daily or twice weekly, giving the greatest household frequency for any study area.

Ninety-one percent of kukora is used by households in Muhlekwane on a daily or twice weekly basis, providing a good opportunity for pathogen transfer given optimal conditions. As with milk, Malapati households show the least frequent use of soured milk, with 20% consuming kukora on a monthly basis only, representing the least risk group for any study area.

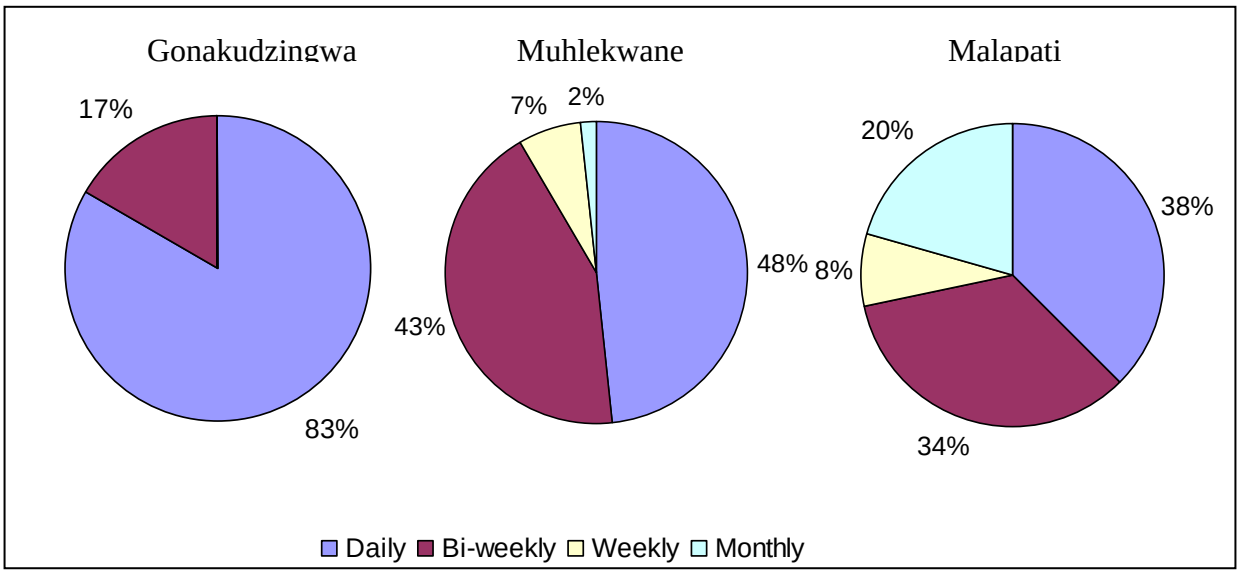



**Figure 15**: Frequency of Household Soured Milk Use, per Area

## 4.21c Soured Milk Use Frequency with Respect to Age

Given the potential for bacterial growth in kukora, we tested the potential for disease transmission (given optimal conditions) based on the frequency of use for each age group.

Although 91% of **babies** in the total population live in households that use kukora, this age group has the least frequent use (20% - 50% within study areas). However, an average of 89% of kukora is used on a daily or twice-weekly basis, and only consumed less frequently in Malapati households. Thus, babies that use kukora are at a **high risk** of pathogen exposure.

Seventy-seven percent of **small children** in the study area use kukora, with up to 100% of consumption within households in Gonakudzingwa. Eighty-nine percent of kukora consumed by small children is on a daily and twice-weekly frequency, with a noticeable drop in consumption to once per month in 22% of Malapati households. This pattern is expressed across all age groups in Malapati, where consumption is split between high and low use frequencies, also observed in milk. However, the frequency and volume of kukora use makes small children a **high-risk** group for pathogen exposure.

Seventy percent of **children** in the study area use kukora, with **consumption patterns that mirror those of small children**. Noticeable differences are seen in Muhlekwane, where only 68% of the total child population use kukora, with 7% on a less frequent weekly basis. This may reflect a reduction in kukora availability in some households, as adult consumption is also reduced in this area. However, children remain a **high-risk group** for exposure to kukora-borne pathogens.

| Study Area | Frequency of Soured Milk Use | Baby (0 - 12 months) | Small Children (1 – 8 years) | Children (9 – 15 years) | Adults (16 – 59 years) | Grandparents (60 and older) |
|---|---|---|---|---|---|---|
| Gonakudzingwa | Daily | **86** | **75** | **83** | **83** | **100** |
| | Bi-weekly | 14 | 25 | 17 | 17 | - |
| | Weekly | - | - | - | - | - |
| | Monthly | - | - | - | - | - |
| Average Use per Week (days) | | 1.4 | **6** | 5 | 5.1 | 5.6 |
| Muhlekwane | Daily | **67** | 50 | 57 | 43 | - |
| | Bi-weekly | 33 | 50 | 36 | 43 | **100** |
| | Weekly | - | - | 7 | 11 | - |
| | Monthly | - | - | - | 4 | - |
| Average Use per Week (days) | | 2.9 | **5.1** | 4.8 | 4.4 | 3.5 |
| Malapati | Daily | **50** | 33 | 39 | 34 | 33 |
| | Bi-weekly | 17 | 33 | 35 | 40 | 33 |
| | Weekly | 17 | 11 | 4 | 6 | 17 |
| | Monthly | 17 | 22 | 22 | 20 | 17 |
| Average Use per Week (days) | | 1.6 | 3.3 | 2.7 | **4.3** | 2.5 |

**Table 8**: Frequency of Soured Milk Use per Study Area and Age Group

**Adult consumption of kukora is the least frequent overall**, although 73% of the total population are consumers (See Tables 8 & 9). The reduced frequency of use, with 20% of adults in Malapati consuming on a monthly basis, reflects patterns of milk use for this area. Further analysis of household diets will provide more guidance as to the reason for this reduction in use, although it is suggested that households with insufficient quantities may prioritise consumption by children over adults. With a high percentage of use overall, adults are at risk of pathogen exposure through kukora consumption, with localised areas of reduced risk.

**Grandparents** have a low consumption of kukora as a percentage of the population (43%). However, where kukora is available within the household, between 75% - 100% of grandparents consume the product. Eighty-nine percent of consumption is on a weekly or bi-weekly basis, with a reduction in frequency observed in Malapati, in keeping with patterns in all age groups in the area. With high levels of consumption within households, grandparents are at **high risk** of pathogen exposure, although the overall risk to this group is less at the population level.

Given the potential for pathogen longevity in soured milk products, the higher frequency of **kukora consumption** at household and population level presents a **greater risk** for disease than **milk** consumption. Greater analysis will be required to determine the prevalence of bacteria within different age kukora, with a view to providing public health information based on the use of increasing acidity to kill bacteria. Until then, the potential for soured milk products to act as a media for pathogen transfer between livestock, the environment and people should not be underestimated.

| Study Area | Age Group | Percent of total population who live in soured milk using households | Percentage of household members who use soured milk | Percentage of total population who drink soured milk | Potential soured milk use increase (of total population) |
|---|---|---|---|---|---|
| Gonakudzingwa | Baby | 83 | 20 | 17 | 83 |
| | Small Children | 82 | **100** | **82** | 18 |
| | Children | 89 | **100** | **89** | 11 |
| | Adult | 70 | **86** | 60 | 40 |
| | Grandparents | 83 | **80** | 67 | 33 |
| Muhlekwane | Baby | 55 | 50 | 27 | 73 |
| | Small Children | **92** | **91** | **83** | 17 |
| | Children | 78 | **87** | 68 | 32 |
| | Adult | 87 | **100** | **87** | 13 |
| | Grandparents | 20 | **100** | 20 | 80 |
| Malapati | Baby | **100** | 44 | 43 | 57 |
| | Small Children | 68 | **84** | 57 | 43 |
| | Children | 70 | 77 | 54 | 46 |
| | Adult | 73 | **98** | **71** | 29 |
| | Grandparents | 71 | 75 | 53 | 47 |
| Area Averages | Gonakudzingwa | 80 | 90 | 72 | 28 |
| | Muhlekwane | **84** | **95** | **80** | 20 |
| | Malapati | 72 | 86 | 62 | 38 |

**Table 9**: Soured Milk Use as a Percentage of Household and Area Populations

## 4.21d Knowledge and Consumption of Raw Soured Milk (Obj.1&3, Th.2,3&4)

To understand the potential for household and cultural practices to increase or reduce disease risk, we assessed the effect of any preparation practices prior to consumption on pathogen potentials.

As soured milk products rely on bacteria to alter the consistency and flavour of the milk, no households reported treating or boiling milk used in this process, as this will often kill the bacteria that are essential for production.

**One household** in Malapati reported boiling the soured milk product prior to consumption, which represents 5% of the soured milk consumed in this area, and 2% overall. The reason for boiling the soured milk was to **kill bacteria prior to consumption**, although this alters the taste and consistency of the product.

It is unlikely that public health programmes would achieve success if they require the boiling of soured milk products, or the milk used in their manufacture. Until more locally relevant measures can be found to reduce the potential for pathogen transfer, **the use of soured milk products is a high-risk practice for communities in the GLTFCA,** especially for households that report zoonotic diseases in livestock populations.

## 4.22 Meat Use as a Practical Risk Factor for Disease (Obj.1&3, Th.2,3&4)

Like other animal products, meat preparation and consumption are risk factors for pathogen exposure and disease transmission from animals to people. To understand the practical risk factors associated with meat use as part of the local diet, we assessed meat use in each of the three study areas.

### 4.22a Meat Use

All households in each study site report eating meat as part of their diet. In Muhlekwane and Malapati, 100% of individuals within each age group eat meat In Gonakudzingwa, 12% of grandparents did not eat meat, giving a 94% meat use for this area overall.

### 4.22b Meat Type

All households reported the use of **chicken** and **goat** meat throughout the study areas. In addition, **nine wildlife species** were reportedly consumed across the three study sites, with 5 to 7 different species reported in each area. **Wildlife consumption** was greatest in Gonakudzingwa (100% of households), compared to 37% of households in Malapati and 19% in Muhlekwane.

The type of wildlife meat consumed varied between study sites, with **impala** (70%), **antelope** (60%) and **bushbuck** (40%) reported by the greatest percentage of households (See Table 10). Large mammal species made up the majority of species in Muhlekwane and Malapati, where communities benefit from access to meat rations distributed by neighbouring hunting conservancies. As a result, **buffalo** meat was reported by 30% of households in Malapati, 12% in Muhlekwane and 10% in Gonakudzingwa, while **elephant** meat was used by 25% of households in Malapati and 9% in Muhlekwane.

Smaller species including **springbuck** (possibly referring to small antelope species that 'pronk' when disturbed) **guinea fowl** and **fish** were also listed, although this was very localised by household and area.

| Wildlife Species | Gonakudzingwa | Muhlekwane | Malapati |
|---|---|---|---|
| Antelope | **60** | - | 2 |
| Buffalo | 10 | **12** | **30** |
| Bushbuck | **40** | 3 | 2 |
| Eland | - | - | 4 |
| Elephant | - | **9** | **25** |
| Fish | - | - | 2 |
| Guinea Fowl | 10 | - | - |
| Impala | **70** | 9 | 11 |
| Springbuck | 10 | 3 | - |
| Total Number of Species | 6 | 5 | 7 |

**Table 10**: Percentage of Households reportedly eating wildlife species, per area

## 4.22c Frequency of Meat Use

The frequency of meat consumption is greatest in Gonakudzingwa, where 72% is consumed at a daily or bi-weekly rate (See Figure 16). Muhlekwane and Malapati have similarly low meat consumption rates, with 50% of meat being consumed either on a weekly or monthly basis.

## 4.22d Frequency of Meat Use with Respect to Age

In comparison to milk and soured milk, meat is consumed at a much slower rate in all study areas. In parallel with milk use patterns, **no babies consume meat** in Gonakudzingwa, where 50% of children of all ages, and adults eat meat twice per week. Grandparents consume meat at the slowest frequency, with 40% of individuals eating meat once per month, but have the greatest average number of meat meals per month overall (12 days per month)(See Table 11).

In Muhlekwane, grandparents consume the least amount of meat, averaging one meat meal per month. In contrast, babies receive their greatest number of meat meals of any study area, with 33% eating meat daily, averaging 16.7 meals per month. This is the highest frequency of consumption for any age group in any area, placing this susceptible age group at risk of disease depending on meat cooking practices. Sixty-one percent of meat consumption in Muhlekwane is on a monthly basis, averaging 3 and 8 meat meals per month. **Children** in this area receive the least number of meat meals (3.3) per month of any age group across all study sites.

Forty-six percent of meat meals are consumed on a monthly basis in Malapati, although this is mirrored by 34% consumed on a bi-weekly or weekly basis. A small percentage of children (6%) and adults (10%) eat meat on a daily basis, while babies receive the least number of meat meals per month (4.5) which is half of adult quantities (8.9 meals per month).

Meat use provides a risk of exposure to disease across all age groups within the study area. However, as meat consumption is expensive, or requires the slaughter of household livestock, the number of meals available per month is dependent on access to other sources of meat. It is therefore not surprising that **wildlife is consumed within the GLTFCA area**, although this will introduce different risks for disease transmission than encountered through consumption of livestock meat only.

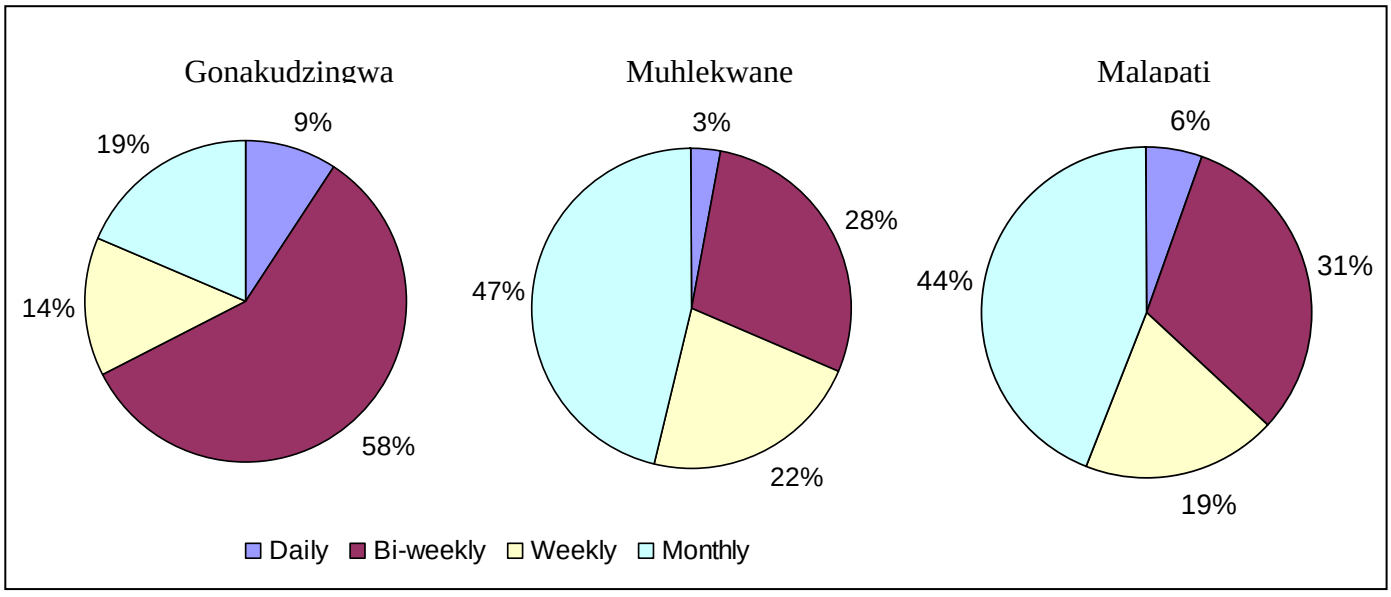



**Figure 16**: Frequency of Household Meat Use, per Area

| Study Area | Frequency of Meat Use | Baby (0 - 12 months) | Small Children (1 – 8 years) | Children (9 – 15 years) | Adults (16 – 59 years) | Grandparents (60 and older) |
|---|---|---|---|---|---|---|
| Gonakudzingwa | Daily | - | 10 | 13 | 10 | 20 |
| | Bi-weekly | - | **50** | **50** | **50** | 20 |
| | Weekly | - | 20 | 13 | 20 | 20 |
| | Monthly | - | 20 | 25 | 20 | **40** |
| Average Use per Month (days) | | - | 9 | 10.1 | 9.7 | **11.9** |
| Muhlekwane | Daily | 33 | - | - | 3 | - |
| | Bi-weekly | 33 | 27 | 25 | 32 | - |
| | Weekly | 33 | 29 | 25 | 23 | - |
| | Monthly | - | **53** | **50** | **42** | **100** |
| Average Use per Month (days) | | **16.7** | 5.8 | 3.3 | 8.1 | 1 |
| Malapati | Daily | - | - | 6 | 10 | - |
| | Bi-weekly | 25 | 28 | 31 | 33 | 40 |
| | Weekly | 25 | 20 | 22 | 17 | 10 |
| | Monthly | **50** | **52** | **42** | **40** | **50** |
| Average Use per Month (days) | | 4.5 | 5.8 | 8.4 | **8.9** | 8.1 |

**Table 11**: Frequency of Meat Use per Study Area and Age Group

## 4.23 The Importance of Wildlife for Household Meat Consumption (Obj.1, Th.2,3&4)

To understand the importance of wildlife meat for household consumption, and the possible implications for household exposure to disease, we assessed the proportion of wildlife to livestock meat consumption across age groups and study areas.

Wildlife meat consumption is reported by **100%** of households in Gonakudzingwa, 17% in Muhlekwane and 37% in Malapati. The use of livestock and wildlife meat in all Gonakudzingwa households will require more detailed analysis to ascertain the contribution of wildlife meat to household meat consumption. This will be obtained through analysis of household diet information over the coming months. However, households in Gonakudzingwa have the **highest number of meat meals across age groups for any area** (9 – 12 per month), and will present risks of pathogen exposure, especially from contact with wildlife meat.

Muhlekwane shows the greatest variation of meat use between age groups (See Figure 18), with babies consuming an average of 16.7 meat meals per month. Little benefit can be seen for children, adults and grandparents in wildlife consuming households, where meat consumption remains static or experiences a reduction in households with access to wildlife meat.

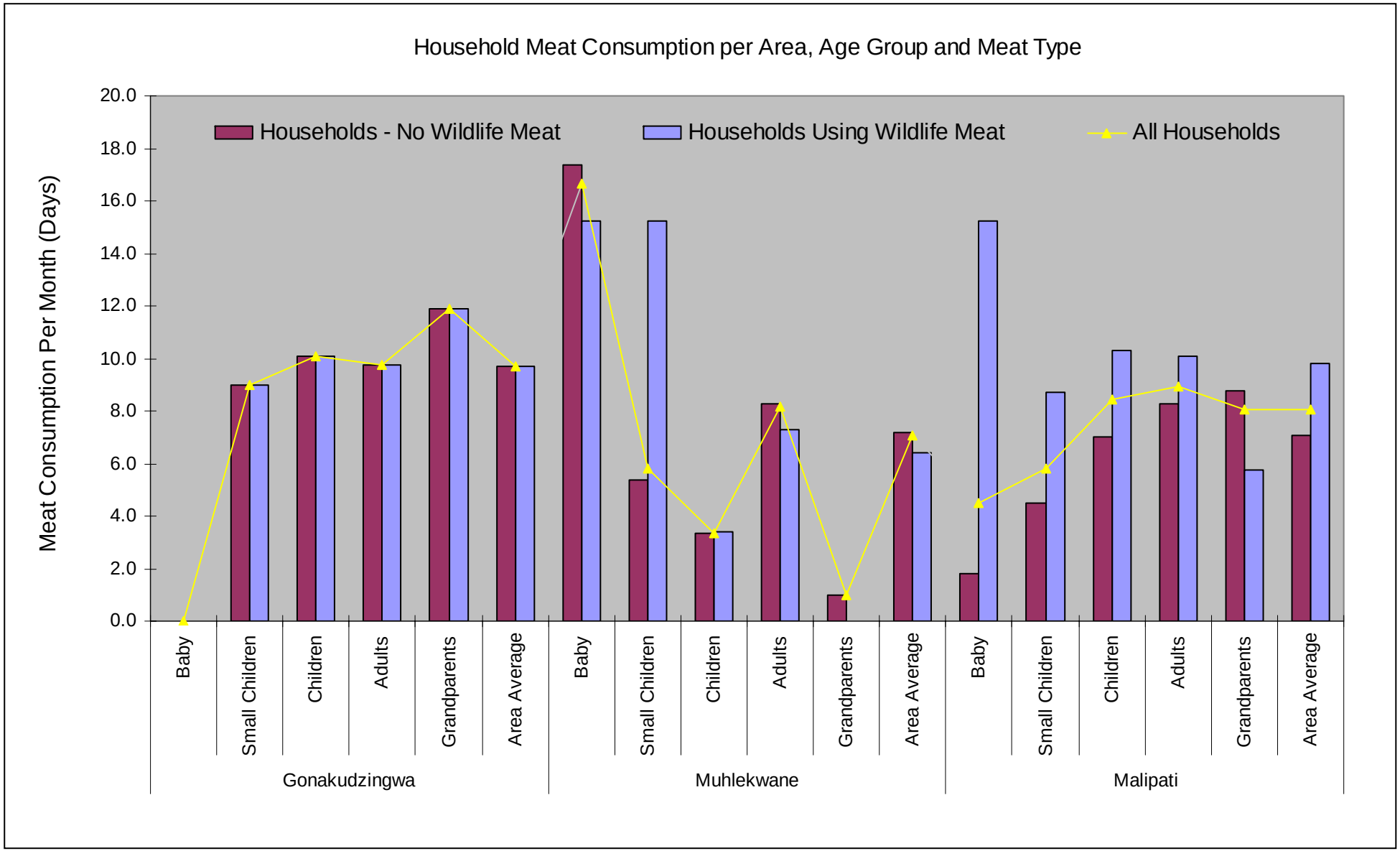



**Figure 18**: Household Meat Consumption per Area, Age Group and Meat Type

More analysis of household diet may explain this pattern, although households in this area have the fewest number of cattle, goats and chickens, and may therefore have been expected to rely more on wildlife meat than other study areas. **Small children** are the only age group to **benefit** from access to **wildlife meat**, where average monthly meat meals increase by an estimated 10 meals, according to preliminary analysis.

In Malapati, households with access to wildlife meat show a **consistently higher meat consumption rate** across all age groups, except grandparents. Babies benefit the most, with an average increase of 13 meat meals per month compared to those in non-wildlife eating households. This is the greatest increase in meals for any age category in any study area, placing babies most at risk of pathogen exposure, depending on the cooking methods used.

## 4.24 Wildlife Meat Consumption and Wildlife Sightings (Obj.1, Th.2,3&4)

Although these analyses are preliminary, access to wildlife meat provides a great source of protein for households in all areas. Data analysis of household information will provide insight into the source of this meat, although it is believed to be partially derived of rations provided by local hunting areas.

Household contact with wildlife, as reported at home, water points and grazing areas, increase the ease by which people may obtain wildlife without the need to hunt within park areas. Comparison of wildlife meat consumption indicates some correlation with household wildlife sightings across all study areas.

Of the 16 wildlife species reportedly seen by households at home, water points or in grazing areas, **38%** were also reportedly **consumed** in each area. These include antelope, buffalo, bushbuck, elephant, guinea fowl and impala. In addition, three species that were not reportedly seen, were listed as consumed, and will require further investigation.

As seen in Table 12, a greater percentage of households in Gonakudzingwa report eating than observing wildlife in their area. Further investigation will be required to understand the source of this meat. However, **70%** of households have **seen** species that they **consume** in **grazing areas**, 40% at water points and 30% at the homestead.

In Muhlekwane and Malapati, most species are seen more often than they are consumed. In Muhlekwane, **66%** of households **see wildlife** species that **they consume** in **grazing areas**, 33% at water points and 33% at home. This is similar to Malapati**,** where **45%** of households **see wildlife** species they **consume** while **grazing cattle**, 25% at water points and 20% at home.

The high contact rate between wildlife and people therefore suggests that the level of wildlife meat reported by households in all study sites is entirely possible within the GLTFCA. This will be assessed further with the analysis of more detailed household information over the coming months. The risk of disease through consumption of wildlife meat will need greater attention, especially with increasing numbers of pathogens are documented within Zimbabwean wildlife.

| Wildlife Species | Gonakudzingwa | | Muhlekwane | | Malapati | |
|---|---|---|---|---|---|---|
| | See (%) | Eat (%) | See (%) | Eat (%) | See (%) | Eat (%) |
| Antelope | 40 | **60** | - | - | 8 | 2 |
| Buffalo | 10 | 10 | 67 | 12 | 45 | 30 |
| Bushbuck | 7 | **40** | 9 | 3 | 26 | 2 |
| Eland | - | - | - | - | - | 4 |
| Elephant | 13 | - | 58 | 9 | 47 | 25 |
| Guinea Fowl | - | **10** | - | - | 2 | - |
| Impala | 60 | **70** | 12 | 9 | 47 | 11 |
| Springbuck | - | **10** | - | 3 | - | - |

**Table 12**: Percentage of Households Who Eat and See Wildlife Species
(Red Text Denotes Species where reported consumption is greater than quantity seen)

## 4.25 Meat Use and Disease Risks (Obj.1, Th.2,3&4)

Using wildlife and domestic animal meat places household members at a different and potentially increased risk of pathogen exposure and infection. The wide variety of wildlife species consumed will increase the diversity of household pathogen exposure. Preparing carcasses and meat is also a risk factor, especially in households with no access to clean water, which may struggle to maintain meat hygiene protocols designed to minimise risks.

## 4.25a Raw Meat Consumption

All households in Gonakudzingwa reported consumption of cooked meat only. In Malapati**, 6%** of households reported consuming **uncooked meat**, although none was derived from wildlife species. Less than 10% of the population consumed this meat, except for babies, who ate uncooked meat on 20% of occasions.

When uncooked meat was available, 50% of grandparents, 100% of adults and 75% of all children participated. This accounted for at least one meal for small children per month, 2 for babies, 4 for children, 5 for adults, and over **15 meals for grandparents** within these households, placing them at the highest risk of disease.

Meat was consumed uncooked due to **taste preferences**, and it is not known if it was prepared in any way prior to consumption. The addition of salt or vinegar to sun dried meat may reduce the longevity of bacteria and disease risk, and will require further investigation.

Seven percent of households reported consuming uncooked meat in Muhlekwane, which represents 33% of wildlife consuming households in this area. Less than 3% of the population consumed uncooked meat overall, with no consumption by grandparents, but up to 10% by babies. In households where uncooked meat was available, 100% of babies and adults and 33% of small children and children participated. This may represent up to 15 meat meals per month for babies and small children, 4 for children and 8 for adults.

As these households consume **buffalo and elephant** meat along with goat and chicken, the potential for pathogen exposure is more complicated than in households who do not consume wildlife meat.

As in Malapati, meat was consumed uncooked for **taste preferences**, which is particularly common with goat meat. If wildlife meat is consumed uncooked, large mammal species obtained from local hunting areas may reduce the risk of disease, as permits are required from veterinary and police authorities prior to distribution through local butcher outlets at growth points.

Consumption of other uncooked animal products was also reported, including '*Masiya*', a blood and salt based drink that is consumed on occasions by all age groups. Clotted blood may also be cooked and consumed, although the exact procedures involved in these practices are unclear and will require further investigation to assess the risk of disease.

## 4.26 Summary

The majority of households within this portion of the GLTFCA have multiple opportunities for pathogen exposure through the use of water and food consumption. Household practices involved with water and milk collection, milk use and meat consumption will require more detailed analysis before the exact risks of disease can be determined for each activity. This preliminary analysis highlights the need for greater awareness regarding disease risks from these natural resources. Few households boil milk prior to consumption, with many 'apparently' sanitary practices conducted for taste preference rather than hygiene purposes.

With risks seen across all age groups, it is important that public health programmes target these aspects of disease to prevent increases of zoonotic disease within remote communities, where poor access to health services will allow disease transmission from wildlife and livestock to people, to remain undetected. With an increasing number of diseases detected in wildlife species, the consequences of transmission to livestock and people around the GLTFCA will not only hamper local development, but also place strain on local health services, and reduce support for conservation programmes. Thus, it is in the interests of the GLTFCA to work with national human and animal health authorities to increase disease awareness and assess risks at local levels in communities within the area.

## 4.27 Human Health and Illness in the GLTFCA (Obj.2&3, Th.2&4)

Poor human health has the ability to impact on land use, natural resource use and household stability, which often leads to unsustainable agricultural and land use practices. In disease affected households, children may take on greater responsibilities, and have to make decisions based on less experience. Families desperate for money for food, transport to medical facilities or medical bills may report to sales of precious livestock, from which they derive protein and vitamins that are hard to replace in the locally poor diets.

The consequences of human illness on the success and sustainability of the GLTFCA requires greater analysis. Here, we describe the current level and types of illness affecting households with the three study areas.

## 4.28 Human Illness

Over 50% of households in Gonakudzingwa and Malapati, and 62% of households in Muhlekwane have been affected by human illness in the 3 months prior to this study. Consequently, **63**% of the population overall are **living in households affected by illness**, with the greatest burden in Malapati (71%).

**Sixteen illnesses** were reported in the area (see Table 14), with the majority seen in Malapati (94%), Muhlekwane (63%) and least in Gonakudzingwa (31%). **Adults** experience the most number of illnesses (88%), which drops to 38% in children, 33% in small children and grandparents, and only 13% in babies. Illnesses were only reported in adults and grandparents, apart from in Malapati, where health issues were reported in all age groups.

## 4.29 Human Illness and Household Resilience (Obj.2&3, Th.2&4)

Households that experience illness in adults and grandparents are typically the least resilient to other household shocks that may occur. Illness in these age groups removes those usually responsible for maintaining household income, decision making and food availability. Families with illness also require greater sources of income to pay for medical bills, transport to health facilities, and increased food needs associated with ill health and medication.

Of those households reporting illness, **100%** in Gonakudzingwa have illness in either an **adult** or **grandparent**, leaving these households vulnerable to shocks and dissolution (See Table 13). This is also high in Malapati (71%) and Muhlekwane (71%), where 5**%** report illness in both adults and grandparents simultaneously.

Despite Malapati showing the greatest spread of illness across age categories, only 4% of households have simultaneous illness in an adult and child age category**.** Illness in multiple age groups will hinder the support and potential recovery of these household members, with fewer healthy people available to take care of the sick.

| Percentage of Households with sickness in: | Gonakudzingwa | Muhlekwane | Malapati |
|---|---|---|---|
| Babies | - | - | 5 |
| Small Children | - | **19** | 5 |
| Children | - | 10 | **30** |
| Adults | **80** | **67** | **62** |
| Grandparents | 20 | 10 | 11 |
| | | | |
| Adult only | **80** | **62** | 30 |
| Children or younger only | - | 29 | 27 |
| Adults or Grandparents | **100** | **71** | **73** |
| Adults and Grandparents | - | 5 | - |
| An adult and a child category | - | - | **4** |

**Table 13**: Percentage of Sick Households with Age Stratification Categories

| Illness | Baby | Small Children | Children | Adults | Grandparents |
|---|---|---|---|---|---|
| Flu | - | 13 | 7 | **18** | 8 |
| Malaria | **50** | **25** | **75** | 14 | **58** |
| TB | - | - | - | 8 | - |
| Lung Problems | - | 13 | 7 | 7 | - |
| Heart and Chest | **50** | - | - | 3 | - |
| Diarrhoea | - | **25** | 4 | - | - |
| Snake Bite | - | - | - | 1 | - |
| Swollen Leg | - | **25** | - | 11 | 17 |
| Broken Bones | - | - | 4 | - | - |
| Swollen Head | - | - | 4 | - | - |
| Missing | - | - | - | 6 | - |
| Paralysis | - | - | - | 3 | - |
| Headache | - | - | - | **15** | - |
| HBP | - | - | - | 5 | 8 |
| Eye | - | - | - | 1 | 8 |
| Mental Illness | - | - | - | 11 | - |
| Back Pain | - | - | - | 2 | - |

**Table 14**: Cause of Illness as a Percentage of Age Group Illness

## 4.30 Causes of Human Illness

As different illnesses cause a range of disabilities over various time durations, it is important to quantify the types of illness affecting households, and the potential consequence on household life. Infectious diseases and chronic illness have the capacity to cause long-term changes to the mobility of patients, and can often affect multiple household members simultaneously.

**Malaria** is the most widely reported illness, accounting for **31%** of all reported sickness, and is the major reason for illness across all age groups, except adults (See Table 15). Sixty-one percent of cases are reported in **Malapati**, which is probably due to the proximity of the Mwenezi River, which is an ideal breeding ground for mosquito larva. Malaria is least reported in Gonakudzingwa (4% of reported illness), where it only affects grandparents. However, **headaches** (which account for 7% of reported illnesses overall) account for 25% of adult illness in this area, which may be associated with Malaria or other vector borne problems, although not professionally diagnosed.

During the three months prior to this study, **flu** was the second most reported illness (15%) in all age categories except babies. This was consistently reported in all three study areas over two seasons, and may also be responsible for the high levels of headaches and lung problems described.

**Tuberculosis** (TB) was reported as the cause of 5% of illness overall, but was only reported in adults, despite local clinics documenting cases in children, babies and grandparents. In Muhlekwane, TB accounts for **20% of adult illness** and 7% in Malapati, but no cases were reported in Gonakudzingwa. The long clinical progression and stigma associated with TB mean that it is not easily recognised or openly reported. As **lung problems** are the third most reported illness overall (9%), with similar distributions in Muhlekwane and Malapati, more investigation will be required to assess the true role of TB in household health.

| Reported Illness | Gonakudzingwa | Muhlekwane | Malapati | Overall Percentage |
|---|---|---|---|---|
| Malaria | 4 | 35 | **61** | **31** |
| Flu | 9 | 18 | **73** | **15** |
| Lung Problems | - | 29 | **71** | **9** |
| Headache | 20 | 20 | **60** | **7** |
| TB | - | **75** | 25 | 5 |
| Swollen Leg | 25 | **50** | 25 | 5 |
| Heart and Chest | - | - | 100 | 4 |
| HBP | - | 33 | **67** | 4 |
| Diahorea | - | - | 100 | 3 |
| Paralysis | - | - | 100 | 3 |
| Mental Illness | 50 | 50 | - | 3 |
| Snake Bite | - | - | 100 | 1 |
| Broken Bones | - | - | 100 | 1 |
| Swollen Head | - | - | 100 | 1 |
| Eye | - | - | 100 | 1 |
| Back Pain | - | 100 | - | 1 |
| Missing | - | 67 | 33 | 4 |

**Table 15**: Cause of Illness per Study Area

Of those households that reported TB, **81%** had **other illnesses** in the family in Malapati and **22%** had **more than one person with TB infection**. Thirty percent of TB reporting households in Muhlekwane had other illnesses, with 20% having more than one person with the infection. No reports of zoonotic TB infection were received, although local clinics describe **cervical lymphadenitis** in children, which may suggest localised infection of bovine tuberculosis. Long-term chronic and infectious illness emanating from TB infection has the capacity to pressure households and reduce their resilience significantly. Patients require lengthy care and access to good food and water supplies, which places additional strain on household finances and activities.

**Diarrhoea** accounts for 3% of illnesses overall, but was only reported in Malapati, where it was responsible for **50**% of illness in **small children**, and 7% in children. The close proximity and use of the **Mwenezi River** may be play a role in these problems, especially when it forms the main supply of drinking water for the household (10%), and is shared with their cattle (100%).

**Swollen legs** cause 5% of illness, but account for up to **50%** of problems in **small children** in Malapati, 25% of adult illness in Gonakudzingwa and 50% of complaints in Muhlekwane grandparents. Along with reports of paralysis (3% overall), there is no immediate explanation for these problems, although they may be associated with unknown disease or **side effects of medication** for TB or HIV / AIDS.

A range of other illnesses were described in each area, but none could be specifically attributed to zoonotic disease. Despite local hospital records showing high levels of TB, HIV / AIDS and sexually transmitted diseases, these were rarely mentioned by interviewees for understandable reasons. It is therefore essential that collaborations are established between the **GLTFCA and local human and animal health authorities**, to ensure that good diagnosis are provided for the high number of unknown illnesses reported in human and livestock populations. Without this information, the true health burden experienced by rural communities in the GLTFCA will remain unknown, and the consequences thereof for conservation in the area.

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## Perceptions of Disease Risk and Transmission between Wildlife, Livestock and People (Obj.3, Th.6)

Local knowledge on the potential for disease transmission across species can be an important tool to prevent widespread infections. To assess the level of disease knowledge and perception, we asked households to identify any diseases they believed could be transmitted via any direction between wildlife, livestock and people.

### 4.31 Wildlife as a risk for Livestock

Knowledge regarding disease transfer from **wildlife to livestock** was greatest overall, as demonstrated by 75% of households overall, and 90% in Gonakudzingwa (See Figure 19). Good awareness in Malapati (75%) may be partially attributed to recent veterinary and research campaigns addressing the risk of **rabies** and **Food and Mouth Disease** (FMD). Other disease threats included **lumpy skin disease, black leg, bovine tuberculosis** and **anthrax**, most of which were reported to cause cattle mortality during the 3 months prior to the study.

**Buffalo** were mentioned as the main risk species by 100% of farmers in Muhlekwane, 88% in Malapati and 78% in Gonakudzingwa, who were concerned with FMD and bovine tuberculosis infections. **Impala** were also perceived as a threat for FMD in Gonakudzingwa, where they are seen by 35% of families at home. **Kudu** and other antelope were also mentioned as potential carriers of FMD, while **wild dogs** were perceived as the greatest threat for rabies transmission.

The high and mostly correct perceptions of wildlife as a disease risk for livestock will play a role in disease control within local communities. However, should outbreaks of diseases occur that are perceived to come from wildlife, this will have serious implications for species survival and conservation programmes in the GLTFCA.

### 4.31a Livestock and as Risk for Wildlife

Considering the widespread knowledge of disease risks caused by wildlife to livestock, only 30% of households were certain that this relationship can also be reversed. Twenty-seven percent of household believed livestock could not transmit disease to wildlife, while the majority (53%) were unsure.

Gonakudzingwa had the greatest awareness of any study area, with 40% of households mentioning dogs and cattle as potential transmitters of **FMD** and **rabies** respectively. The six percent of farmers in Muhlekwane who believe there was a risk mention rabies transmission from **dogs.** This is opposite to 25% of households in Malapati, who considered **cattle** to be the only risk factor, for FMD and lumpy skin disease.

### 4.31b Livestock as a risk for People

Forty-two percent of households were uncertain if livestock could pose a disease risk for people, while **38% believed no risk was possible**. This low awareness was particularly prevalent in Muhlekwane, where only 6% of households believed there was a risk, and all mentioned **Anthrax**

transmission from **cattle**. **Dogs** were seen as the major risk factor for transmitting **rabies** in Gonakudzingwa, with slight knowledge on transmission of Anthrax from cattle.

Farmers in Malapati were the only ones to mention **goats** (7%) and cattle (80%) with links to Anthrax and FMD. Malapati was also the only area to report possible transmission of **bovine tuberculosis** from cattle to people, which may reflect contact with local research programmes, and was attributed to 20% of risks from cattle overall.

With high levels of meat and milk use, the poor knowledge of potential zoonotic disease transmission from livestock to people will require urgent attention by local animal and human health authorities.

## 4.31c Wildlife as a risk for People

Most households (46%) were uncertain if wildlife could transmit disease to people, with 39% believing it was not possible. Twenty percent of people in Gonakudzingwa, and 3% in Muhlekwane thought wildlife could transmit disease to people, with all households giving examples of **rabies** infections from wild dogs. As it is unlikely that rabies transmission will occur in this way, due to the shy nature of wild dogs, farmers may be referring to infection via contact between **wild dogs** and domestic dogs, which may later infect humans. However, if wild dogs are perceived as a disease threat, this will be detrimental to the conservation of this endangered species, and requires careful management and public outreach.

Malapati residents demonstrated the best knowledge, mentioning transmission of **rabies** from wild dogs; **FMD, bovine tuberculosis** and **Anthrax** from **buffalo**, and some definite but unidentified threats from **warthog**. With consistent sightings of buffalo outside park areas, residents are right to be concerned with the threat of disease, although in many instances, infections will more likely be transmitted via an intermediate livestock host. This perceived threat of disease should be considered a serious threat for successful conservation in the area in the event of disease outbreaks over the coming years.

## 4.31d People as a risk to livestock

Only **1%** of respondents (located in Gonakudzingwa) believed that people could transmit diseases to livestock, with the majority (60%) believing it could not occur, and the remaining feeling unsure. **Flu** was described as a potential disease risk; although it is not certain if this refers to avian flu specifically, or fevers in general.

## 4.31e People as a risk to wildlife

**Two percent** of respondents believed people could be a threat to livestock, with 63% stating it could not happen and the rest undecided. Of the 3% and 2% of households in Muhlekwane and Malapati who mentioned the possibility, **none could state a disease or wildlife species at risk**.

The level of knowledge of disease transfer from **people** to **animals** is the lowest overall. It will be essential to improve this awareness, to establish greater appreciation of the interconnectivity of disease between livestock, wildlife and human populations, if future health programmes are to be effective in the GLTFCA.

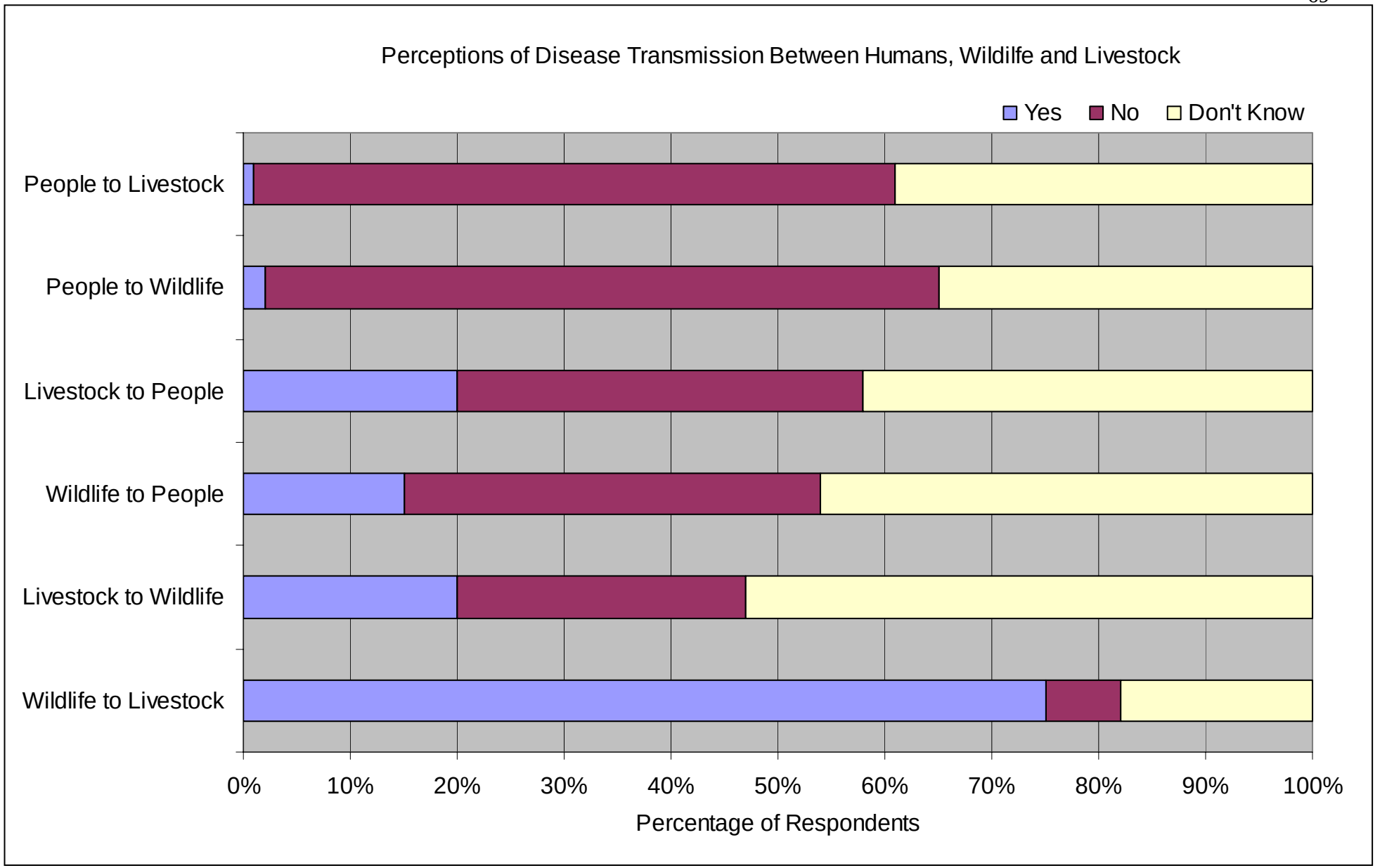


**Figure 19**: Household Awareness of Disease Transmission Potentials between Human, Wildlife and Livestock Populations

## 4.32 Awareness of Disease (Obj.3, Th.6)

Overall, seven diseases were identified that could be transmitted between wildlife, livestock or people. **Sixty-one percent** mentioned **FMD**, 12% anthrax, 10% rabies, 5% TB, 4% lumpy skin, 1% black leg, 1% flu with 7% of respondents unable to name specific disease threats. The high perception of rabies threats may be due to local annual vaccination and public outreach campaigns, although no related illness or mortalities were mentioned during health screening in the area.

## 4.33 Summary

Poor levels of disease knowledge and transmission potential between wildlife, livestock and people is a concern, especially where communities report high use of animal food products, and overlap between people and animals at home, water points and on grazing areas. Wildlife are considered the major threat to livestock and people throughout the three study sites, although few households believed transmission could occur in the opposite direction. With a combined 98% of livestock and human pathogens able to infect wildlife, the risk of newly emerging infectious diseases should not be underestimated in this region.

Public health campaigns must include education on the real threats and transmission potentials between wildlife, livestock and people to help prevent disease spread, and to minimise the blame placed on wildlife should disease outbreaks occur. This has the capacity to damage support for the GLTFCA and must be addressed as part of community outreach projects immediately

# Section 5: Discussion

Quantifying disease risk across multiple groups within a changing social, political and environmental landscape is complicated. This study has identified three factors that influence the potential for disease transmission across the human, wildlife and livestock interface in this part of the GLTFCA. These drivers include:

1. The potential for high frequency contact between wildlife, people and their livestock at food, water and other natural resources
2. Poor access to good quality and affordable human, animal and wildlife health services
3. Poor communication between communities, health and conservation authorities, resulting in out-dated and often incorrect perceptions of disease risk, health concerns and conservation awareness.

Addressing these issues will take commitment and financial investment and at a national level. However, by identifying the practical risk factors for disease transmission between groups, and documenting the current health concerns and perceptions of disease within local communities, the local relevance and effectiveness of targeted health and conservation initiatives can be improved.

## 5.1 Health and Disease within the GLTFCA

Infectious, chronic and zoonotic diseases are affecting human, livestock and wildlife populations within the study area. High levels of disease places strain on households, health services and natural resources within the GLTFCA, as households increasingly rely on the environment to provide food, traditional medicines, shelter, fuel and revenue. Reducing the burden of disease within communities, both in human and livestock populations, will ease the pressure on local ecosystem goods and services, and increase local population and environmental resilience.

## 5.2 Current Health Concerns within the GLTFCA

The presence and magnitude of infectious and emerging diseases is consistently under-estimated in communities with poor access to health care and testing facilities. With 50% of households in the study area reporting illness in family members, or cattle mortality due to disease, there is a need for increased testing for disease in the area. With several infectious diseases causing symptoms similar to Malaria and flu, and a lack of experienced trained health professionals in local communities, there is great potential for misdiagnosis in the area.

The paucity of facilities and clinicians will also allow newly emerging and zoonotic diseases to remain undetected by human or animal health services, providing time for these infections to spread to susceptible individuals and between populations. As most cattle mortalities are attributed to ‘unknown disease’, testing is urgently required in this area, to assess the full spectrum of pathogens present. Resource scarcity also inhibits the ability to test wildlife in Gona-re-Zhou National Park, although historical records and recent research indicate a range of zoonotic and infectious pathogens are present within the population

Diseases currently identified, and of concern within the GLTFCA study areas are:

Human: Malaria, Tuberculosis, HIV/AIDS, sexually transmitted infections, respiratory illness and diarrhoea

Livestock: Foot and Mouth Disease, Heart water, Gall Sickness, Bovine tuberculosis, Anthrax, Lumpy Skin Disease, January Disease, Brucellosis, Rift Valley Fever and Rabies.

Wildlife: Foot and Mouth Disease, Anthrax, Bovine tuberculosis, Brucellosis, Rift Valley Fever and Rabies.

## 5.3 Disease Transmission and Spatial Spread

The potential for infectious and zoonotic diseases to spread within and between human, livestock and wildlife populations is dependent on the type and frequency of contact between susceptible individuals and populations.

Transmission of disease within cattle populations takes place due to high levels of contact between individuals in over-night enclosures, water and grazing areas. The potential for diseases to spread within the GLTFCA area is also high, due to the sale and purchase of animals for financial and cultural reasons. Sick and potentially infectious animals from herds with recent disease mortalities were sold by households throughout the area. Although the majority of sales were to neighbouring areas, which limits the risk of disease introduction and spread, 11% of cattle were sold to owners in Mozambique. With the majority of these animals coming from herds with recent disease mortalities, including Anthrax, greater monitoring and regulation is required to prevent the transmission of disease to areas throughout the GLTFCA.

Cattle sales, purchases and movement were driven in most cases by the need for money to buy food, and to pay school fees and hospital bills, or provide animals for cultural rituals, marriage or traditional healing. Poor human health, food availability and financial security are therefore playing a role in the dissemination of disease by driving cattle sales in the GLTFCA.

## 5.4 Disease Transmission across the Wildlife, Livestock and Human Health Interface

### 5.4a Practical Risk Factors and Food Safety

High levels of livestock ownership within the GLTFCA study area will facilitate the spread of diseases between animals and people at a household level. As livestock are used to provide food and drought power, daily contact between people and animals is an unavoidable risk for zoonotic pathogen transmission. With different family members responsible for small and large livestock species, the risks of disease infection are spread across all age groups. And, as multiple diseases can infect each livestock species, households will be exposed to a diverse range of pathogens, which will increase with the types and densities of species owned. Analysis of agricultural practices and typical livestock species assemblages should therefore be used to target vaccination, testing and health education campaigns that are relevant to for livestock owners in each community.

Contact between people, livestock and wildlife is most frequent around natural food and water resources, and is the greatest risk for disease transmission between these groups. As many households report seeing large and small herbivore species at home, and while taking livestock species to water points and grazing land, there is potential for direct and indirect transmission of disease between these groups.

Direct transmission of pathogens from wildlife to people is less likely to occur, but is possible if wildlife are trapped for food, or in rare circumstances, attack humans. The transfer of wildlife pathogens to people is more likely to occur by indirect transmission routes, via livestock or through environmental contamination at water and food collection points.

## 5.4b Food-borne Zoonoses and Disease Awareness

The widespread inclusion of animal-derived foods in household diets poses one of the greatest risks for zoonotic disease transmission in the GLTFCA. Consumption of bacteria in poorly prepared milk, dairy and meat has the potential to infect a large proportion of household members, and the wider population through informal sales. Consumption of bacteria is also a concern for predators that are frequently exposed to pathogens in wildlife and livestock prey species, and are susceptible to emerging diseases like bovine tuberculosis.

Preliminary analysis of household diets suggests a high reliance on meat and milk for protein and vitamin requirements, which are missing in other available foods. Milk and soured milk are used on a daily basis by most age groups, and rarely boiled or treated prior to consumption. With poor access to clean running water and indoor milking areas, milk collection is often unhygienic. This increases the pathogen load of dairy products regardless of the disease status of the cow; making the consumption of raw milk and dairy products a major risk for human health in the GLTFCA.

Poor awareness of disease risks may be responsible for the lack of milk and dairy product treatment before use. In households that reported boiling milk before consumption, more than half did so to suit taste preferences rather than food safety concerns. It is essential that these issues are included in local public health programmes to reduce the capacity for zoonotic transmission by this route.

Although meat is consumed less frequently than dairy products, it also presents a risk for zoonotic infection in most households and age groups in the area. As wildlife meat forms an important part of household diets for more than half of the interviewed households, this increases their potential exposure to a wider range of pathogens than those who only consume livestock.

Although the majority of meat is cooked prior to consumption, some households reported a preference for sun-dried meat, which may increase the potential for zoonotic infections depending on the exact methods used. Disease risks will also be present during the preparation of animal carcasses for meat and extraction of skin and other products used for food, medicine and traditional costumes.

Diseases risk will therefore be greatest in households with multiple potential transmission pathways through milk, soured milk and wildlife and livestock meat.

## 5.5 Perceptions of Disease

Perceptions of disease varied across the area, with commercial farmers having the greatest knowledge of disease overall. This may be related to their interaction with food inspection officers at district abattoirs, who will prevent the sale of their meat if diseases are identified. The greater economic wealth of these household may also give them an advantage due to better access to communications, media, transport and health care when needed. For the majority of households, poor access to public health, veterinary and medical services has restricted their knowledge of disease and disease risks associated with contact between species.

Of all the possible disease transfer mechanisms between wildlife, livestock and people, more households could provide examples of the risks posed by wildlife to livestock than any other relationship. Here, farmers were aware that contact with wildlife presents risks for Foot and Mouth Disease, Rabies, Bovine tuberculosis, Anthrax and Lumpy Skin Disease, which all affect local cattle populations. Recent research and testing activities on these diseases in some areas may have increased local knowledge, although this may or may not be retained over the long term.

Wildlife was also perceived as a risk for human health by a small percentage, who mentioned the risk of rabies transmission by wild dogs. Direct transmission of rabies is unlikely given the normal behaviour of this species, but may be associated with outreach programmes describing risks from domestic dogs in the area. Farmers located near to the animal health services had a greater perception of zoonotic risks, mentioning contact with buffalo as a factor for transmission of Foot and Mouth Disease, bovine tuberculosis and anthrax. However, the actual risks of disease will vary depending on the frequency and type of contact with these usually unsocial animals.

Livestock were rarely perceived as a disease threat for wildlife, which highlights the lack of knowledge upon which households build their perception of risk. Livestock were mentioned as a risk for human health in a small number of households, who all mentioned rabies transmission by dog bite. This is a concern considering the high levels of frequent contact between people and livestock in this area, and use of animal products. Slightly greater knowledge was exhibited by households near to animal and human clinics, who have had more exposure to public health education and small-scale testing programmes.

People were not perceived to play any role in animal health through transmission of disease to livestock or wildlife, which is understandable due to the paucity of information regarding animal health in the area.

## 5.6 Summary

With so little knowledge and perception of disease risks, many households are engaging in high-risk behaviour on a daily basis through food and natural resource use. Many practical risk factors are the result of essential daily household and agricultural activities, and cannot be prevented outright. These risks are exacerbated by the poor control of disease and movement of wildlife and livestock in the area, and lack of public health programmes.

The overall dearth in knowledge and awareness of the links between human and animal health, will lead to problems within the GLTFCA. Wildlife species are currently perceived to be the main, and often only, risk of disease for livestock and people in the area. Thus, disease outbreaks will often be attributed to local parks, regardless of the actual cause of infection, bringing consequences for park management, community relations and support for GLTFCA activities.

These issues can be addressed by increasing the dissemination of information on the multiple and bi-directional links between human and animal health, through clinics, schools and local organisations. With little capacity to prevent disease in animals, increasing public health activities will give people the opportunity to make informed decisions regarding riskier behaviour. Greater communication will also help to reduce incorrect assumptions regarding the risks of disease transmission between wildlife, livestock and people.

# Section 6: Conclusion

By engaging with communities in the GLTFCA, this project has demonstrated the need for improved human, livestock and wildlife health care throughout the area. With the capacity for wildlife, livestock and people to move across park and community lands, it is essential that the links between these groups are explored, discussed and analysed as a baseline for the development of a GLTFCA disease policy.

As healthy households breed healthy landscapes, the GLTFCA must engage with national human and animal health agencies to improve access to good quality human and animal health services, while supporting the surveillance of diseases within wildlife populations. Communication between communities, park authorities and health departments is desperately needed to increase understanding of the issues faced on a daily basis by households in the GLTFCA area. Only then can locally-relevant actions be prioritised.

As disease has the capacity to drive social change and natural resource use, it is imperative that a formal disease policy is developed for the GLTFCA. This should prioritise public outreach and community health development along with protocols to monitor and minimise the transmission of disease across wildlife, livestock and human populations at local and regional scales. With interventions targeted to make best use of the limited resources available, improvements in health care, disease awareness and perceptions of conservation and disease can be achieved. Without this commitment, the influence of pathogens on parks and people may kill all hope for regional conservation in the GLTLFCA.

## 6.1 Project Evaluation

This project has contributed to the aims set out by the AHEAD-GLTFCA working group, by conducting ‘inter-disciplinary applied research at the interface between wild and domestic animal health, and human livelihoods and well-being’.

It has contributed to our understanding of animal health and disease (Themes 2 and 3) by obtaining and ground truthing basic information on livestock populations and the spatial and temporal patterns of human and livestock disease, as reported by households and health professionals in the GLFTCA study areas.

It has also assessed the current costs and benefits associated with disease in households and livestock with respect to human livelihoods and natural resource use (Theme 4). This information will be used to support policy development within the GLTFCA (Theme 5).

## 6.1a Project Objectives

All the objectives of this project have been achieved. We have identified the practical risk factors for disease transmission between wildlife, livestock and human populations in the GLTFCA (Ob. 1), recorded the current disease concerns affecting each group (Ob 2.), and assessed the awareness of zoonotic disease risks (Ob. 3) in households within the GLTFCA.

Ongoing analysis will provide estimates of current and potential impacts of zoonotic disease on the health of communities, livestock and community initiatives, which can be used for policy development within the GLTFCA (Ob. 4).

## 6.1b Additional Contributions

This project endeavoured to build local capacity through the involvement of local people, professionals and students. As such, this project has contributed to the professional development of 3 students (2 x Zimbabwe, 1 x South Africa) and a number of local health professionals, park staff and academic collaborators.

Students have benefited from their involvement in this project through training in social and health orientated questionnaire design, database design, statistical analysis and data dissemination (written and oral). They have also acquired valuable practical experiences relating to the implementation of community-based research, which will be useful as they continue their careers in scientific and health research.

The involvement of local stakeholders and households was an integral part of this project, which led to greater communication and exchange of information between communities, local health providers and the research team. By increasing the contact between communities and health workers, this project helped to improved access to information, and generated incentives for communication and ongoing relationships that should continue beyond the duration of this project.

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