

Water supply and its perceived impacts in Tulipamwe informal settlement of Eenhana in northern Namibia

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ABSTRACT Water supply is one of the pressing challenges facing human settlements, especially informal ones. This paper aims to assess water supply in Tulipamwe informal settlement of Eenhana town in northern Namibia. Specifically, we explore the impact of water availability, accessibility and quality on local households and quality of life, as perceived by residents. The study employs a quantitative approach, using a structured questionnaire. We adopted simple random sampling to select 25 housing units for sampling. Of our respondents, 75% reported to have adequate water supply. The majority of the respondents' households (95%) have access to taps (communal or private), while 5% rely on open water sources. Half of the respondents perceived water as clean, while almost half of the respondents perceived water cleanliness as either average (35%) or poor (10%). Viewed in a broader context, water supply in Tulipamwe is comparable to most informal settlements in Namibia and elsewhere in southern Africa. Our findings reaffirm the need for improved service delivery to people residing in informal settlements, both on a local and regional scale.

KEYWORDS water accessibility; water affordability; water quality; water scarcity; quality of life; informal settlement; Namibia

INTRODUCTION

Water supply is one of the most pressing challenges facing our societies. The issue manifests itself in various forms, such as water scarcity, unaffordability and contamination. More than two billion people reside in countries subjected to high water stress (UN DESA 2023). By the year 2030, the intensity of water scarcity could displace 700 million people globally (UN-Water 2021). This stresses the severity of the problem at a global scale. The 1999 United Nations Environment Programme (UNEP) Global Environment Outlook (UNEP 1999) predicted that in the year 2025, as many as 25 African nations, roughly half of the continent's countries, will be expected to suffer from a combination of increased water scarcity and

water stress. At the time of the writing this paper, administrative data collected via United Nations (UN) SDG Indicator 6.4.2 (which measures the level of water stress as freshwater withdrawal against available resources) showed that the early UNEP warnings were remarkably accurate, though the nature of the crisis can often be traced back to economic water scarcity rather than just physical absence. This means that despite sufficient water resources in the area, financial, infrastructural and institutional capacity limit its access and distribution (FAO & UN-Water 2024).

Water scarcity is more acute in informal settlements of developing countries' urban areas (UN-Habitat 2026). While approximately 74% of formal urban populations globally utilise safely

managed drinking water services, less than half of the households in informal settlements have access to on-premises, regulated water infrastructure (WHO & UNICEF 2025). Across southern Africa, expanding informal settlements and growing concerns over water availability in general have brought water supply issues to the forefront. According to UN-Habitat (2015), informal settlements are characterised by housing arrangements operating outside formal land administration and legal frameworks. This includes land tenure insecurity, lack of municipal service infrastructure, and non-compliance with municipal building codes. In South Africa, for example, water provision in informal settlements is far below the required standard of a minimum of 25 l of water per person per day for direct consumption through cooking and personal hygiene (Muzondi 2014). Chipeta (2009) found that because of poor water supply in Mabyani, an informal settlement of Blantyre in Malawi, people have no choice but to rely on unsafe water sources of shallow wells or rivers in their surroundings. Consuming contaminated water risks exposure to various waterborne related illnesses. About 1.4 million people die each year from water-related diseases, with children under five accounting for nearly 395 000 of these fatalities (Wolf et al. 2023).

Namibia is an especially interesting and important case study, given its largely arid or semi-arid climate. Water resources are therefore more limited than elsewhere in sub-Saharan Africa (Heyns 2005), and water supply challenges are characterised by often unique and variable aspects. Faulstich et al. (2023) demonstrated that during a prolonged five-year drought in the semi-arid Cuvelai-Etosha Basin of central-northern Namibia, intense pressure on local surface water bodies, specifically ephemeral drainage channels and natural pans, led to severe water and sediment pollution. Due to high evaporation rates and heavy anthropogenic and livestock use, these open water sources suffered from extreme turbidity and elevated salt concentrations (such as calcium and sodium). Crucially, the study uncovered high concentrations of metals like aluminium in both solid and liquid phases, with direct anthropogenic contamination and serious ecological and public health risks for communities relying on these untreated surface waters. These challenges are then, again, amplified in the country's informal settlements.

Lewis et al. (2018) found that in Goreangab informal settlement of Windhoek, only 11% of the residents live within one kilometre of potable water source while 67% of the residents live between one and five kilometres from a water access point. A study on Kuvukiland, an informal settlement in Tsumeb in northern Namibia, found that due to poor water supply, about 80% of the residents collect water from public toilets in a neighbouring settlement (Enkono and Mosimane 2016). According to a recent report from the Namibia Statistics Agency, approximately 200 000 urban residents live in informal settlements across Namibia. Nationally, only 23.9% of informal settlements have fully implemented bulk water infrastructure, with 44% of informal settlements relying exclusively on communal taps with no other municipal facilities (NSA 2026).

With this paper we add to a growing body of work that details the challenges people residing in Namibia's informal settlements face, in terms of water supply. By using Tulipamwe, an informal settlement of Eenhana in northern Namibia, as a case study, we explore how residents experience and perceive different dimensions of water supply. Our focus is specifically on water availability, sources, accessibility, affordability, quality and their associated impacts on residents' lives.

METHODS

Study area

Tulipamwe informal settlement (hereafter referred to as Tulipamwe) is situated in Eenhana (17.46667 S; 16.33333 E) in northern Namibia (Figure 1). Eenhana is the administrative capital of the Ohangwena Region. Census data suggest that Eenhana's population increased from 5 528 inhabitants in 2011 to 16 588 inhabitants in 2023, with at least 88% of the urban households in the Ohangwena Region having access to safe water (NSA 2024).

Tulipamwe's primary water supply is the municipal reticulation system managed by the local authority in conjunction with the national water utility, NamWater. Historically, this semi-arid region has relied heavily on bulk treated surface water piped through extensive open Calueque-Oshakati Canal and pipeline infrastructure drawing from perennial systems

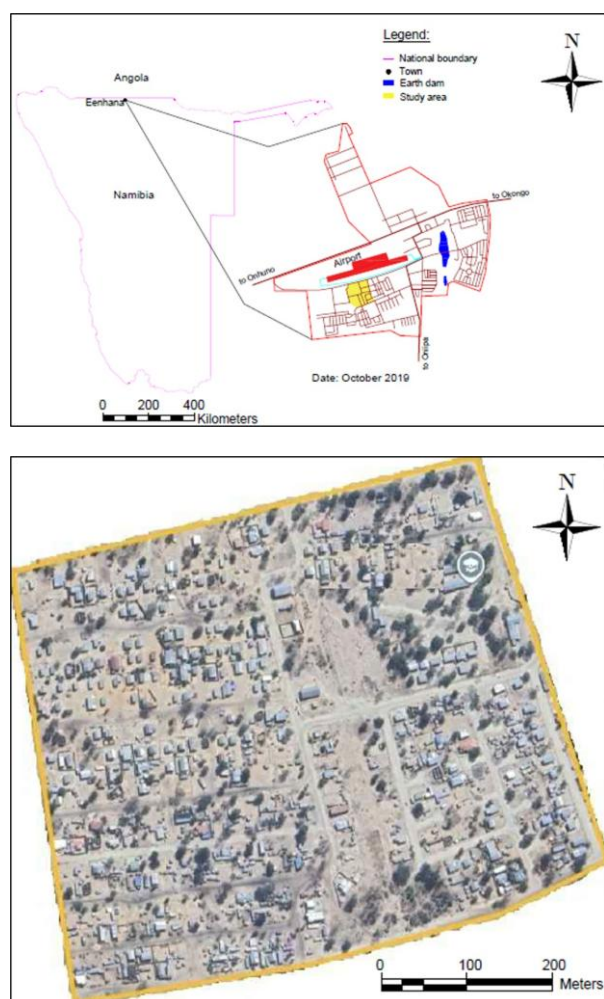


Figure 1 Location of the study area within Namibia and Eenhana (top) and a satellite image of Tulipamwe informal settlement (bottom).

along the northern national borders. To distribute this water within peripheral, rapidly expanding, and economically vulnerable areas like Tulipamwe, local governance frameworks have progressively introduced communal standpipes equipped with prepaid water systems (Frick-Trzebitzky et al. 2022, Salom & Khumalo 2022). This structural configuration aims to improve municipal service delivery, enforce cost-recovery strategies, and mitigate the extreme financial strain on low-income, informal households by replacing unregulated, informal connections with a baseline, structured access to potable municipal water (Salom & Khumalo 2022).

However, systemic volume suppressions, frequent infrastructural dysfunction, and rapid urban migration in northern Namibia limit the reliability of this surface-piped network, forcing a regular reliance on localised groundwater alternatives.

Tulipamwe and the broader Eenhana municipality sit directly above the extensive Ohangwena Aquifer system, which serves as a strategic reservoir for the region. While municipal and rural water supply points utilise boreholes to tap into this regional aquifer system to alleviate water scarcity, the raw groundwater frequently exhibits severe water quality constraints (IGRAC 2015). Over the years, communities tapping into these groundwater sources have been subjected to high levels of salinity and total dissolved solids, creating instances where local populations are forced to choose between erratic municipal pipe flows or unsuitable groundwater for survival. To counteract these limitations, recent infrastructural interventions by the state have shifted toward installing decentralised water purification technologies, using localised reverse osmosis and small-scale desalination units to upgrade raw groundwater to acceptable national drinking standards before distributing it to the informal settlement pipelines (Salom & Khumalo 2022).

Prior to conducting our study, a Town Council official was consulted to give more information on the town's water supply and particularly on the settlement. The official revealed that the town's main water supply comes from the main pipeline at the settlement of Omafo in Helao Nafidi, 50 km to the west, which, in turn, comes from the Kunene River, about 200 km to the west of Helao Nafidi. To supplement the main pipeline, the Town Council official revealed that there are two boreholes in the town that also supply people with water, mostly in informal settlements including Tulipamwe.

Survey methodology

We adopted a survey-based approach, using a structured questionnaire to collect the data (Appendix 1). Our survey was conducted with the permission of the Eenhana Town Council. In total, we randomly selected 25 housing units based on Google Earth imagery. Based on our assessment of these images, Tulipamwe consists of approximately 230 housing units, meaning that our sample amounted to roughly 11% of the settlement's total housing units. The small sample size was primarily the result of resource and operational constraints, and we acknowledge it as a considerable limitation of this study. Nevertheless, the qualitative insights gathered provide a meaningful snapshot of the socio-

environmental pressures active within the settlement.

Using a grid, we selected housing units in a way that ensures equal spatial representation of participants within the surveyed area. In May 2019 we interviewed one person per housing unit, with our focus being on housing unit owners. When the owner was not at home, another member of that housing unit was requested to complete the survey, provided they were at least 21 years of age and had been residing in the settlement for at least two years. All respondents were asked to give informed consent to participate in the study and were given information on the research before filling out the questionnaire.

Our questionnaire was designed to explore the respondents' perceptions and assessments of different aspects of the settlement's water supply. Questions were aimed at gathering more detailed information on the availability, sources, accessibility, quality and affordability of water in the study area. The survey was carried out by the lead author and questions were simplified to ensure that they were understandable by the majority of the literate respondents. While the questionnaire was designed in English, the lead author was able to translate into Oshikwanyama and Oshindonga languages, where respondents' English proficiency was limited. Questionnaires were handed to the respondents who completed them in the presence of the researcher and handed them back upon completion.

RESULTS

Water sources

A quarter of respondents perceived water availability as having an impact on their daily lives, with the remaining three-quarters indicating that they have readily available water (Figure 2a). The vast majority (95%) of our study respondents indicated that their household's water is being supplied through taps except for a small percentage that draws their water from open sources of ponds and water pans (Figure 2b). The respondents who draw water from open sources shared that they approach Eenhana Town Council and more affluent community members for water during the dry season when water sources have dried up.

Water access

A quarter of the respondents reported to have access to water inside their households, 20% inside their plots and half outside the plots at nearby community water points (Figure 3). A small percentage (5%) of respondents fetch their water from further away, which can be more than 5 km. That means that 55% of the respondents do not

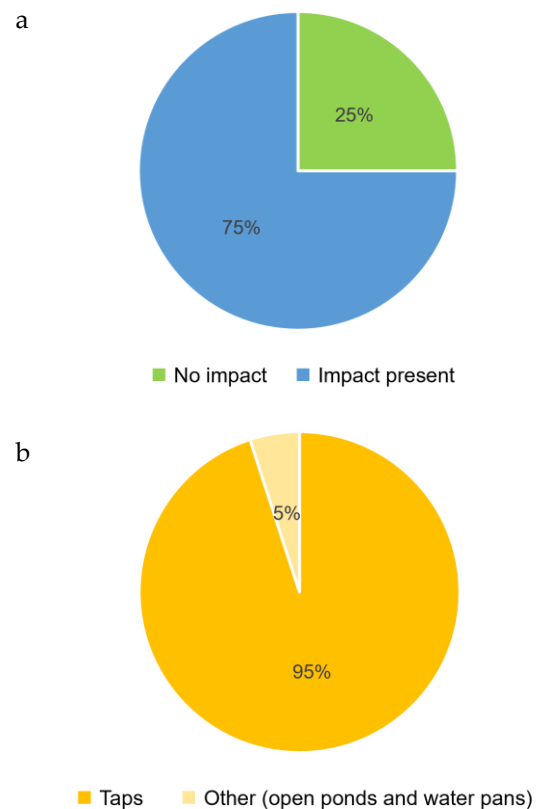


Figure 2 Respondents' perceptions of (a) the impact of water availability on their households and daily life, as well as descriptions of (b) the water sources in Tulipamwe informal settlement.

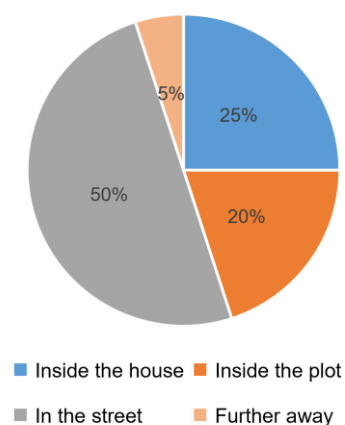


Figure 3 Water accessibility in Tulipamwe informal settlement.

have water either in their houses or their plots. This group lacks independent access to water, leaving them entirely dependent on purchasing it from private owners or commercial vendors.

Water quality

Respondents showed varying perceptions concerning the quality of their water. Only half of the respondents perceived the water as clean (Figure 4). None of the respondents has perceived water as very clean, hence this category not appearing in Figure 4 although it was an option in the questionnaire.

Respondents who perceived water to be clean explained that this was because the water is drinkable, while the remaining respondents revealed that their water was a bit viscous, salty, and smelly, resulting in water quality being assessed as either average or poor.

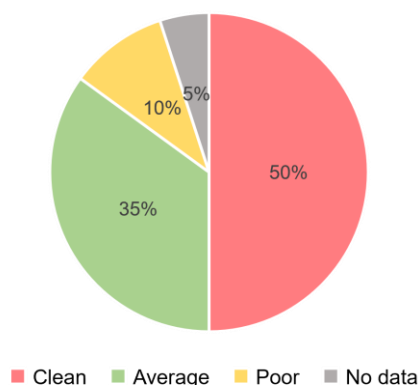


Figure 4 Respondents' perceptions on water quality in Tulipamwe informal settlement.

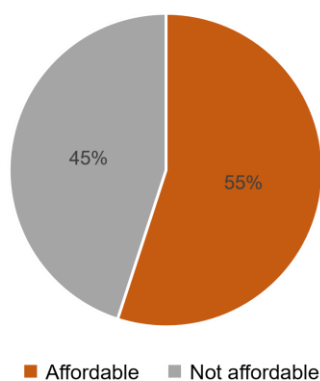


Figure 5 Respondents' perceptions on water affordability from local vendors in Tulipamwe informal settlement.

Water affordability

There is no standard water price in the settlement but respondents reported varying prices ranging from NAD 5.00 to NAD 7.00 per 25-litre container. Figure 5 depicts respondents' perceptions of water affordability in the settlement, illustrating that almost half of the respondents' households cannot afford water from the local vendors.

Water supply and quality of life

In Tulipamwe, the state of water supply impacts on the residents' quality of life mainly through bathing, time spent on collecting water, water quality and availability as per respondents' perceptions. Due to the widespread absence of indoor water facilities (see above), the vast majority of residents reported that they are forced to bathe using makeshift outdoor or informal setups (Figure 6) - something that detracts from their quality of life and leaves them vulnerable to harsh environmental elements like wind and dust.

Several of the respondents shared that residents are exposed to the public while bathing, which significantly infringes on their basic right to privacy. Beyond these immediate privacy concerns, these structures drive broader, systemic sanitation failures across the area. Because the settlement lacks formalised greywater drainage or disposal infrastructure, contaminated wastewater from these makeshift setups flows directly onto open plots and into public streets. This unmanaged pooling of surface water creates, for example, localised points for pathogenic transmission. Respondents expressed concern over children potentially playing in these contaminated pools,



Figure 6 Example of a makeshift bath that people use for bathing within Tulipamwe informal settlement.

which drastically increases their vulnerability to waterborne diseases or infections.

Respondents who perceived water quality as either average or poor qualified their evaluations with experiential accounts, noting that they or members of their households had suffered from gastrointestinal ailments, such as diarrhoea, which they directly attributed to the quality of their water supply. Almost half of our survey respondents reported to have suffered from waterborne diseases within their households within the last year.

DISCUSSION

Our study explored informal settlement residents' perceptions of water supply and how it impacts their lives and quality of life. Using descriptive data from Tulipamwe in Eenhana, we have illustrated how water access, affordability and quality continue to affect and shape the lives of people residing in Namibia's informal settlements.

We found that 75% of the households that participated in the survey have readily available water, with respondents indicating that water availability does not negatively impact their households. This is notable, given that most urban informal settlements in Africa lack readily available water for a significant proportion of their inhabitants. Within a subcontinental and regional context, feedback from the respondents revealed that water availability is much better than initially expected at the start of the study. However, given that a quarter of the respondents still reported inadequate water availability, concerns remain over water provision in Tulipamwe.

Respondents revealed that water access points differ from household to household, mainly depending on the socio-economic status of the households. Households with higher incomes tend to have water points at their premises, while lower-income households are forced to buy water from higher-income households, which has the potential to aggravate existing inequalities on a localised scale. Of the respondents that took part in our study, one quarter do not have access to water points outside of their housing units, which highlights the extent of unequal water access within Tulipamwe. Our findings broadly align

with other studies in southern Africa. Chipeta (2009), for example, found that in Blantyre's informal settlements only 11% of residents have tap water inside their houses. Water access within informal settlements varies considerably on a national scale. In Goreangab, an informal settlement of Windhoek, Lewis et al. (2018) found that only 11% of residents had nearby drinking water sources (< 1 km), unlike our study area.

Water access is also largely determined by affordability, which again ties into socio-economic dimensions. Water affordability is a challenge throughout Namibia and elsewhere in southern Africa. Enkono and Mosimane (2016) found that 86% of the residents in Kuvukiland, an informal settlement of Tsumeb, cannot afford water. In Malawi's capital Lilongwe, 15% of the households in three informal settlements are unable to install household taps because of high upfront cost of connection and high monthly payments (Adams 2017). Of our respondents, almost half indicated that they cannot afford water, which also corresponded with those without 'in-house' water access. Our findings therefore emphasise how unequal service delivery can interact with socio-economic stratification to compound challenges around water supply within Namibia's informal settlement.

The sources from which people draw their water determine the quality of the water that they consume. Census data found that 21.8% of the Eenhana constituency's households relied on rivers, dams and streams as their sources of water (NSA 2024), while our survey revealed a much smaller percentage within Tulipamwe, which falls within the same constituency. Water drawn from open sources such as ponds, lakes and rivers is more likely to contain microorganisms and solid materials in comparison to water drawn from taps and other closed sources. However, fetching water from open sources is not unique to Tulipamwe or Eenhana. Various studies throughout the world have recorded similar or more extreme situations. For instance, Chipeta (2009) found that the entire informal settlement Ntopwa in Blantyre, Malawi, relies on natural water sources from shallow wells and rivers. In Namibia's case, collecting water from open sources can be deeply entangled with environmental or ecological factors. For instance, surface water in ponds may dry up at particularly

high rates in more arid areas or during more severe droughts, often leaving human users competing with livestock or wildlife for water.

Cleanliness or quality of Tulipamwe's water supply is another aspect that we investigated and found that almost half of our respondents assessed water cleanliness to be an issue within their respective households. The United Nations Human Settlements Programme (UN-Habitat 2003) estimated that only 40% of households in informal settlements of developing countries have access to clean water, making it a widely pervasive issue – including across southern Africa. This presents severe public health risks. It is estimated that water disconnections by South African municipalities in response to non-payment led to 106 000 people being affected by cholera in KwaZulu-Natal between 2000 and 2001, due to unsafe access to water. Cholera, a waterborne disease is known to spread through the consumption of contaminated water. Drawing water from open sources, such as dams or ponds, as reported by a small percentage of our respondents, represents a typical setting that could facilitate the spread of cholera and other waterborne diseases. More than that, our respondents perceived direct links between the quality of available water and the health of their household members. Although these findings capture localised user perceptions rather than clinical medical records, they closely align with regional epidemiological trends. Studies assessing rural groundwater safety across Namibia demonstrate that unimproved or poorly managed water points frequently exhibit high total coliform and *Escherichia. coli* counts, exceeding safe drinking standards and presenting a direct microbiological risk for gastrointestinal distress in local communities (Lewis & Claasen 2018, Tandlich 2009). Consequently, these community perceptions serve as a reliable proxy indicator for broader, documented public health vulnerabilities and systemic water-quality deficits within the settlement.

The lack of secure water, sanitation, and hygiene (bathing) infrastructure directly correlates with an elevated prevalence of diseases, particularly among children under five (Bauleth et al. 2020). This burden is severely exacerbated during seasonal flooding events in northern Namibia

when stagnant water and overflowing, unlined pit latrines mix with greywater pooling, triggering historical outbreaks of critical waterborne illnesses such as cholera, dysentery and typhoid (Anthonj et al. 2015). Ultimately, these intersecting infrastructure and sanitation deficits place a compounding burden on community health and systematically compromise the residents' overall quality of life. While our study's small sample size and overwhelmingly descriptive analysis make it impossible to generalise our findings, we were able to illustrate some common and pertinent issues on a localised scale.

Ultimately, this study suggests that while the state of water supply in the Tulipamwe informal settlement generally surpasses regional benchmarks for sub-Saharan African informal settlements, critical gaps remain that directly diminish residents' quality of life and reveal a stark socioeconomic divide within the resident community. Consequently, pervasive water insecurity among Tulipamwe's most vulnerable residents inflict severe physical, environmental and health-related vulnerabilities on a substantial portion of Tulipamwe's population. Insufficient water quality, coupled with reports of waterborne diseases, highlights an urgent need for water quality testing and improvement. Furthermore, for the 75% of residents lacking indoor water connections, the reliance on makeshift outdoor baths compromises personal dignity by exposing them to dust, wind and public view. For the most vulnerable 5% who rely on open, untreated water sources, potentially fatal waterborne diseases like cholera remain a risk. Despite this study's limitations, our findings contribute to knowledge on water-related issues in Namibia's informal settlements, which policymakers and municipal authorities should find helpful.

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APPENDIX 1

Study Questionnaire

**Water supply and its impacts on Tulipamwe informal settlement of Eenhana town in
Northern Namibia**

Instructions for the completion of the questionnaire:

1. Except when specified otherwise, the information required in this questionnaire applies only to the head of the household.
2. Some questions will require only a cross (X) to be made in the relevant block, while others need a written response. In the latter case, write your response in the space provided.
3. Photographs are important in order to portray reality. For ethical reasons, no person/s will be included in the photographs.

Thank you for your co-operation.

What are your perceptions on the impact of water availability in your household?

	Impact Present	No Impact	Uncertain
Respondent:			

Water resources available to and used by your household

Tap	Yes	No
Water tank		
River		
Dam		
Borehole		
Well		
Other (please specify)		

Indicate the location of the tap used by your household

	Inside the house	In the plot	In the street	Further away
Respondent:				

If further away: What is the approximate distance in Kilometers?

What is the impact of water uninstalation inside your house? (describe)

.....

.....

.....

.....

What are your perceptions on water cleanliness?

	Very clean	clean	Average	Poor	No Data
Respondent:					

Give reason for your choice (describe):

.....

.....

What are your perceptions on water affordability for your household?

	Affordable	Not Affordable
Respondent:		

What are your perceptions of the impact of the quality of the available water resource on the health of the members of your household?

	No impact	Impact present
Respondent:		

Water borne diseases prevalence in your household

	Diarrhea	Stomach worms	Other	None
Respondent:				

If other, please specify/describe:

.....

.....

.....