

**Assessing the consumption of Giant-Jewel Beetles (*Sternocera Orissa*) among rural households in the Lepelle-Nkumpi Local Municipality of Limpopo Province**

by

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A MINI-DISSERTATION

Submitted in (partial) fulfilment of the requirements for the degree of

**Master of Science**

in

**Agriculture (Agricultural Economics)**

in the

**FACULTY OF SCIENCE AND AGRICULTURE (School**

**of Agriculture and Environmental Sciences)**

at the

**UNIVERSITY OF LIMPOPO**

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**2025**

## DECLARATION

I declare that the mini-dissertation hereby submitted to the University of Limpopo, for the degree of Master of Science in Agriculture (Agricultural Economics) has not previously been submitted by me for a degree at this or any other university; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged.

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## ACKNOWLEDGEMENTS

In the interest of honesty, this mini-dissertation would not have been successful without the oversight, assistance, direction, and involvement of my supervisors, Prof M.P. Senyolo and Dr. J.P. Mokhaukhau. Throughout the study, they have provided incredible support and unimaginable patience by offering insightful feedback and suggestions that have made the study's success more significant. Additionally, I want to sincerely thank my family. I appreciate all of your ongoing help and inspiration.

Special thanks to the respondents from the Lepelle-Nkumpi Local Municipality for the crucial role they played in this study and for their patience and time they took to participate in this study. Most importantly, I would like to thank God for without his grace, this study would not have been possible.

## ABSTRACT

In the dry regions of Limpopo Province, South Africa, food security remains a significant issue for many rural households due to the challenges of traditional agriculture and limited access to diverse protein sources. The Lepelle-Nkumpi Local Municipality, which is mainly characterised by its pastoral economy, faces critical socio-economic conditions that restrict the nutritional well-being of the households. In this context, the consumption of edible insects, specifically Giant-Jewel Beetles (*Sternocera orissa*), emerges as a viable alternative protein source. Edible insects are not only rich in protein and essential nutrients but also have a lower environmental impact compared to conventional livestock production, making them a sustainable food option.

This study examined the consumption of Giant-Jewel Beetles among rural households in the Lepelle-Nkumpi Local Municipality of Limpopo Province, South Africa. The research objectives were to identify demographic characteristics of the households, profile the consumption frequency of Giant-Jewel Beetles, and analyse socio-economic factors influencing this consumption, employing Descriptive statistics and a Logistic Regression Model. The results revealed that a significant proportion of respondents (44%) were consuming Giant-Jewel Beetles 1-2 times per week, primarily as a relish.

The results from the Logistic Regression Model provided insights into the factors influencing the consumption of GJBs in the study area. The Logistic Regression results indicated that factors such as age, food expenditure, reasons for consumption, and potential risks of Giant-Jewel Beetles significantly influence the consumption of Giant-Jewel Beetles. The analysis indicated that older individuals were more likely to consume these insects, while higher food expenditure negatively correlates with their consumption.

Based on the findings of the study, there is a need for strategies that promote edible insects as an affordable protein source. Policy makers should consider initiatives that support small-scale insect farming and local value chains, which will enhance the accessibility and affordability of Giant-Jewel Beetles. Additionally, establishing food safety standards for the harvesting and processing of edible insects is important to ensure consumer confidence and mitigate potential health risks.

Keywords: Consumption, Entomophagy, Edible insects, Food security, Giant-Jewel Beetles, Rural households.

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## ACRONYMS

BCE: Before the Christian Era

CGJBs: Consumption of Giant-Jewel Beetles

FAO: Food and Agriculture Organisation

GJBs: Giant-Jewel Beetles

IFAD: International Fund for Agricultural Development

ILO: International Labour Organisation

LPG: Limpopo Provincial Government

SDGs: Sustainable Development Goals

SPSS: Statistical Package for the Social Sciences

Stats SA: Statistics South Africa

TREC: Turfloop Research Ethics Committee

UN: United Nations

## CHAPTER ONE: INTRODUCTION

### 1.1. Background

Edible insects are commonly used as a protein source in Africa, Latin America, China, Thailand, Japan, and among Australian Aborigines (Orkus, 2021). Edible insects play a crucial part in achieving resilient food security. Furthermore, they are nutrient-dense and offer health advantages, contributing to improved global food and nutrition security (Sogari, 2019). This aligns with the United Nation's global food systems transformation goal, which aims to create more sustainable, and healthy food systems (Orsi *et al.*, 2019). Doubled agricultural output is required to feed the world's population, which is predicted to reach 9 billion by 2050 (United Nations, 2019). The shift to a more meat-based diet is also being accelerated by income growth in low- and middle-income nations (Orkus, 2021). Global meat enterprises may face difficulties due to rising meat demand and a shortage of agricultural land (Ghosh, 2019).

Alternative sources of meat protein, like insects, are preferred because conventional sources might not be able to satisfy the demands of the world's expanding population (Sogari, 2019). In 2015, the edible insect market in the United States, Belgium, France, the United Kingdom, the Netherlands, China, Thailand, Vietnam, Brazil, and Mexico was estimated to be worth approximately 33 million dollars (Ancha, 2019). By 2025, the industry is anticipated to reach 522 million dollars, mostly due to rising consumer acceptability and awareness of edible insects worldwide (Orkus, 2021). The United Nations (UN) and Food and Agriculture Organisation (FAO) have been encouraging the consumption of edible insects among their member nations for a number of years because they offer food at a lower environmental cost (for example, fewer greenhouse gas emissions, less feed, and a significant reduction in the amount of farmland needed) (Orkus, 2021).

Additionally, edible insects are high in minerals, proteins, lipids, and vitamins (Eagan, 2019). According to Liu *et al.* (2020), raising insects typically involves less capital investment and technological input, which may enhance living conditions for underprivileged communities. Due to their accessibility and low cost, producing and consuming insects seems to be increasingly appealing to underdeveloped nations. This is especially true for a nation like South Africa, where edible insects lessen poverty and enhance human wellbeing by giving jobless people access to seasonal employment possibilities (Kunjeku *et al.*, 2018).

Edible insects have been a part of the human diet in South Africa from prehistoric times. For instance, Ghosh (2019) found that in the early 100,000 years Before the Christian Era (BCE), South Africans were consuming termites (*Trinervitermes trinervoides*) and honeybees (*Apis mellifera unicolor*). Furthermore, in the early 1950s, the BaPedi people of South Africa continued to consume edible insects for nutritional purposes, according to Quin (1959) and Bodenheimer (2018). In South Africa's Limpopo Province, many tribes, including the VhaVenda, BaPedi, and Vatsonga, mostly consume edible insects these days (Eagan, 2019). Lepidopteran caterpillars, termites, grasshoppers, Giant-Jewel Beetles, ants, and stink bugs are the most popular edible insects consumed in South Africa (Eagan, 2019).

The integration of edible insects into global food systems presents a promising solution to the challenge of achieving food security with the rapidly growing population. Their nutrient density, lower environmental impact, and potential to boost economic opportunities, especially in developing countries like South Africa, underscore their value in transforming food systems towards greater sustainability and health (Sogari, 2019; Orkusz, 2021). As traditional protein sources may become increasingly unsustainable, the expansion of the edible insect market, projected to reach significant economic value in the coming years, highlights growing consumer acceptance and awareness (Ancha, 2019; Orkusz, 2021). The ongoing efforts by international organisations such as the FAO and the UN to promote edible insects align with global goals of sustainable food production and improved nutrition (Orsi *et al.*, 2019). Therefore, edible insects not only offer a viable alternative protein source, but also contribute to resilient food security, making them an integral part of future food strategies (Liu *et al.*, 2020; Kunjeku *et al.*, 2018). This sustainable approach could play a critical role in addressing both current and future food security challenges worldwide.

## 1.2. Problem statement

Entomophagy as defined by Kelemu *et al.* (2015), is the practice of eating insects by humans as a source of food. Edible insects are regularly consumed across the globe by various people as part of their diets. For example, it is reported that many African, Asian, and South American people consume *Acrididae* which are commonly known as locusts, (Yen, 2015; Costa-Neto, 2016). It is recorded that there are more than 2000 bug species that can be eaten by humans around the world (Jongema, 2017). These insects have the

potential to improve food security and provide employment opportunities for various households (Belluco *et al.*, 2013).

Across the world, especially the African continent, edible insects are an essential food source and are important to human nutrition (Anankware *et al.*, 2016; Raheem *et al.*, 2019). African countries have a history of eating insects such as Giant-Jewel Beetles (GJBs), which is scientifically known as the *Sternocera Orissa* (Raheem *et al.*, 2019). Although various scholars have recognised the importance of consuming insects such as the GJBs for nutritional benefits and human development (Baiyegunhi *et al.*, 2016; Manditsera *et al.*, 2018; Belluco *et al.*, 2013), less attention has been recorded on the consumption of GiantJewel Beetles by households and the importance of these Beetles to food security.

Additionally, entomophagy has declined over the years in many communities within emerging nations like South Africa (Neves, 2015). A study by Barton *et al.*, (2020) has also alluded to the decrease in consumption of edible insects, which could be attributed to the poor sensory quality, scarcity, and food anxiety. Despite consumer demand, insect consumption is declining, owing to insect scarcity caused by the uncontrolled application of pesticides, and the most significant entomophagy constraints, which include a lack of expertise in farming insects, harvesting, as well as successful storing and preservation (Dev *et al.*, 2020). Religion and the irritation that comes with eating insects are the major deterrents to consumption among various households throughout the world (Hlongwane *et al.*, 2021). These insects are considered unclean and filthy by many religions, and as a result, they are not permitted to be consumed (Manditsera *et al.*, 2018). Similarly, the decrease in insect consumption is partly ascribed to people's lack of acquaintance, and the discomfort related to eating insects (Awobusuyi *et al.*, 2020). Thus, the idea of eating insects makes some individuals uncomfortable because they see them as pests rather than food (Awobusuyi *et al.*, 2020).

Protein, zinc, and iron deficits are mostly brought on by poverty and a diet low in critical nutrients in Africa (Govender *et al.*, 2017). Consequently, the nutritional impacts of GJBs have the potential to address micro and macro nutrient deficiencies, particularly, in the Limpopo Province given the number of households facing poverty and malnutrition (Claasen *et al.*, 2016). Therefore, it is important to research sustainable food sources that can solve mineral shortages in order to understand how they affect the security of dietary intake. Therefore, the current study aimed to gain insights into the consumption of edible insects

among rural households and to investigate the factors that affect the consumption of these insects. 1.3. Rationale

With more than 842 million people worldwide unable to fulfil their dietary energy requirements, food insecurity remains a significant global issue (Sasson, 2012; FAO, 2013). A staggering 827 million of these individuals live in underdeveloped nations, where starvation and undernourishment are widespread (FAO, 2013). According to FAO (2022), around 2.3 billion people were still food insecure in 2021, which is nearly 30 percent of the global population. Africa continues to have the greatest rates of hunger, malnutrition, and poverty (FAO, 2015). FAO (2017) attested that the majority of people in Sub-Saharan Africa are undernourished. This is due to Africa's susceptibility to food crises and mass starvation brought on by various environmental catastrophes, such as drought and floods, which are likely to exacerbate food insecurity, malnutrition, and hunger (Fombong *et al.*, 2017; Kelemu *et al.*, 2015; Sasson, 2012). Additionally, it is anticipated that food insecurity and malnutrition in Africa will worsen due to rapid population growth and rising food prices (Fombong *et al.*, 2017).

According to Stat SA (2019), approximately 6.8 million people in South Africa lack access to food and suffer from inadequate nutrition. Malnutrition is widespread in low-income homes in South Africa, which is largely due to the country's extreme levels of poverty, income inequality, and unemployment (Sartorius *et al.*, 2020; Tomita *et al.*, 2020). Correspondingly, most South Africans experience food insecurity and lack nutrient-dense, calorie-balanced foods that can satisfy day-to-day nutritional needs (Vorster, 2010; Govender *et al.*, 2017; Tomita *et al.*, 2020). Additionally, households that earn low incomes have no diverse diets. For instance, most of their diets are composed of starchy staples such as maize and bread with lower levels of vegetables and fruits (Claasen *et al.*, 2016; Sartorius *et al.*, 2020). Similarly, food insecurity and unhealthy food can negatively impact the health of human beings and wellbeing, contributing to stunting, protein, and micronutrient (zinc and iron) shortages (McLachlan and Landman, 2013; Govender *et al.*, 2017).

Given these challenges, affordable, inventive, and long-lasting solutions are needed to address the concerns of food insecurity and malnutrition. The FAO has suggested and promoted edible insects such as the GJBs as important protein and food sources that can be able to help provide food security (Fombong *et al.*, 2017; van Huis, 2013). Many African

cultures capture edible insects in the wild and use them as a staple diet (Baiyegunhi *et al.*, 2016). Some authors have recognised the value of edible insects to households as essential traditional delicacies, used as a safety net for food security, crucial for enhancing rural residents' quality of life, traded to make money and are a crucial source of food to supplement diets (Makhado *et al.*, 2014; Manno *et al.*, 2018; Hlongwane *et al.*, 2021).

Fewer studies that talk about entomophagy have been documented in South Africa. For instance, Rumpold and Schluter (2013) and Murefu *et al.* (2019) looked at the nutritious composition of locusts and beetles. Manditsera *et al.* (2018) also looked at the nutritious value of eatable insects in Zimbabwe. Other studies such as Kadam *et al.* (2020) and Feng *et al.* (2018) explored the utilisation of edible insects, while Egan (2013) focused on the cultural and economic significance of edible insects. A study by Belluco *et al.* (2013) reviewed food security and nutritional perspectives of edible insects. Even so, these studies failed to look at the consumption patterns of edible insects among rural households. Given this information gap, the aim of this study was to assess the consumption of Giant-Jewel Beetles (*Sternocera Orissa*) by rural households.

#### 1.4. Scope of the study

##### 1.4.1. Aim of the study

The study aimed to assess the consumption of Giant-Jewel Beetles (CGJBs) as edible insects by rural households within Lepelle-Nkumpi Local Municipality of Limpopo Province.

##### 1.4.2. Objectives of the study were to:

- i. Identify and describe the demographic information of rural households in Lepelle-Nkumpi Local Municipality of Limpopo Province.
- ii. Profile the consumption frequency of Giant-Jewel Beetles by rural households in the study area.
- iii. Analyse the rural household's socio-economic factors that affect the consumption of Giant-Jewel Beetles in the study area.

##### 1.4.3. Research hypothesis

- i. Socio-economic factors such as age, gender and household size do not affect the consumption of Giant-Jewel Beetles in Lepelle-Nkumpi Local Municipality of Limpopo Province.

#### 1.4.4. Organisational structure

This study is divided into five chapters. Chapter 1 provided the background of the study, problem statement, the rationale for conducting the study as well as the study aim and objectives. Chapter 2 presents the literature review, which includes definitions of the key concepts, entomophagy in South Africa, nutritional value of GJBs as well as the economic, cultural and environmental implications of consuming edible insects, and a summary of the literature reviewed. In the third chapter, the study's location, data collection methods, and analysis methods are described. The findings of the empirical analysis are presented in Chapter 4. Finally, the study summary, conclusion, and policy recommendations are presented in Chapter 5.

## CHAPTER TWO: LITERATURE REVIEW

### 2.1. Introduction

This chapter starts by outlining the key terms used in the study and concludes with a summary of previous studies on topics relevant to the present study. Additionally, this chapter gives an outline of the nutritional benefits, cultural importance, and economic and environmental effects of eating edible insects.

### 2.2. Definition of key concepts

#### 2.2.1. Edible insects

According to FAO (2013), edible insects encompass any species of insects that have been incorporated into human diets worldwide, emphasising their role in traditional cuisines in Africa, Asia, and Latin America. In their comprehensive study, Rumpold and Schluter (2013) define edible insects as those species that are intentionally harvested for human consumption due to their nutritional value and sustainability as a food source. According to Van Huis *et al.* (2013), the global consumption of edible insects suggests their potential as a sustainable food source to address food security concerns. In this study, edible insects refer to Giant-Jewel Beetles. Giant-Jewel Beetles (*Sternocera Orissa*) as described by Kagiso *et al.* (2012), is an African metallic wood-boring beetle, which is popularly known by the Pedi speaking people as Lebitsi-Kgomo, and it is largely consumed by rural households in marginal communities of Limpopo Province, South Africa, especially from December to mid-February.

#### 2.2.2. Consumption of edible insects

Consumption of edible insects as described by Shockley *et al.* (2014), refers to the practice of eating insects, which is commonly performed globally as a part of the human diet.

#### 2.2.3. Rural households

According to Ellis (2000), and IFAD (2010), rural households are defined as households located in non-urban area, often characterised by their reliance on agriculture or natural resource-based activities for livelihood.

### 2.3. Entomophagy in South Africa

Entomophagy has historical roots in South Africa, where indigenous communities have long relied on insects as a significant dietary component (Halloran, 2017). Insects are not only a traditional food source but also hold cultural and socio-economic importance in various communities (Van Huis *et al.*, 2013). Insects have long been used by the BaSotho and the San of the Kalahari in South Africa, mostly for food but also for medicinal purposes (Quin, 1959; Monnig, 1967). Quin (1959) compiled a list of 12 bug species that the Pedi tribe in the Sekhukhune area consumed in the 1950s. These did not include insects used for religious, artistic, or medical purposes. According to recent anecdotal reports from anthropologists and entomologists working in rural Basotho communities, insects continue to play a significant role in Basotho culture, which largely carries over into urban areas (Egan, 2013). In South Africa, the majority of studies on edible insects have been on creating lists of edible species, typically accompanied by some details about their nutritional value (Van Huis *et al.*, 2013). Less research has been done on the significance of insects in entomophagy diets and its predictability as a food source that may be obtained from the natural environment, according to Oonincx (2017). Natural resources are used directly for food, housing, and utensils in a large portion of the developing globe, including South Africa, and are sold to raise money (Shackleton, 2020). Insects are a common source of additional protein in the Limpopo Province (Bouchie, 2021).

Several studies have shed light on the broader landscape of entomophagy in South Africa. For instance, Meyer-Rochow (2009) discussed the potential of insects to alleviate food shortages globally, highlighting their nutritional value and ecological benefits. Additionally, previous research had explored the socioeconomic implications of entomophagy, demonstrating its potential as a sustainable food source and income-generating activity for marginalised communities (Van Huis *et al.*, 2013). Rumpold and Schluter (2013) highlighted the efficiency of insect farming compared to traditional livestock in terms of feed conversion rates and environmental impact. Kelemu *et al.*, (2015) emphasised the role of edible insects in improving food security and providing livelihood opportunities in Africa. Similarly, Chakravorty *et al.*, (2016) discussed the economic benefits of insect farming in rural communities, where traditional agricultural opportunities are limited. Research by Van Huis *et al.*, (2013) emphasised the multifaceted role of insects in South African culture. Insects

are not only viewed as a traditional food source but also as symbols of heritage and identity, often incorporated into rituals and ceremonies. Moreover, their availability and affordability make them accessible to communities across diverse socio-economic backgrounds.

#### 2.4. Nutritional Value of GJBs

GJBs, belonging to the *Sternocera* genus, are known for their substantial size and distinctive appearance. While research on the nutritional composition of *Sternocera Orissa* is limited, previous research on other edible beetles highlighted their high protein content, essential amino acids, vitamins, and minerals (Rumpold and Schluter, 2013). Understanding the nutritional value of GJBs is crucial for assessing their potential contribution to the dietary intake of rural households in Limpopo Province. Rumpold and Schluter (2013) have extensively examined the nutritional profiles of various edible insects, shedding light on their rich content of essential nutrients, and these findings indicated that beetles, including those within the *Sternocera* genus, are rich sources of protein, essential amino acids, vitamins, and minerals. Bombay locust, scarab beetle, house cricket, and mulberry silkworm were found to have a high protein content of 27–54g per 100g of edible portion in a more recent study conducted in Thailand that examined the protein, amino acid, and mineral makeup of these insects (Nakamaru, 2021). In many Central African countries, where their market value is higher than that of the majority of animal-derived protein sources, insects typically account for more than 50% of dietary protein (Lange, 2021). Mealworms and crickets, two edible insects that are currently being considered for consumption in the developed world, have a fresh weight protein level of 19–22 g/100 g, which has been demonstrated to be equivalent to typical animal protein sources (Lange, 2021).

Studies exploring the nutritional content of specific beetle species offer further insights into their potential as dietary supplements. For instance, research by Hanboonsong *et al.* (2013) investigated the nutritional composition of the bamboo borer beetle (*Dinoderus minutus*) and highlighted its high protein content, with levels comparable to conventional meat sources. Similarly, studies on the mealworm beetle (*Tenebrio molitor*) by Oonincx (2017) demonstrated its rich profile of essential amino acids and minerals, making it a promising insect for addressing malnutrition. As a result, a variety of minerals can be found in insects. The majority of edible insects provide large amounts of phosphorus that satisfy the dietary needs of adults (Rumpold and Schluter, 2013). Additionally, according to Kohler (2019), a number of bug species particularly crickets, locusts, and grasshoppers—provide a

substantial quantity of magnesium. Additionally, most people agree that insects are a healthy source of calcium, iron, zinc, manganese, copper, and selenium (Oonincx, 2017). Indeed, studies have demonstrated that edible insects have higher levels of calcium, zinc, and iron than beef, pig, and chicken, indicating that entomophagy may be a viable alternative for obtaining these nutrients (Raheem *et al.*, 2019).

## 2.5. Cultural significance and acceptance of edible insects

The acceptance of entomophagy, including the consumption of beetles, is often influenced by cultural factors and perceptions surrounding food. Studies have shown that cultural norms and beliefs play a significant role in determining which insects are consumed and how they are prepared (Meyer-Rochow, 2009). Van Huis (2013) discussed the various cultural practices related to entomophagy across different countries. The author emphasised that in many African and Asian cultures, insects like grasshoppers, caterpillars, and termites are considered traditional delicacies and are often integrated into local cuisines (Van Huis, 2013). These cultural practices are deeply rooted in the historical context and ecological conditions of the regions (Raheem *et al.*, 2019). The acceptance and preparation methods are influenced by local traditions, availability, and nutritional knowledge passed down through generations (Ghosh, 2019). Yen (2009) explored the role of cultural heritage in the consumption of insects, particularly focusing on Indigenous communities in Australia. The author highlighted that for many Indigenous cultures, insects are not only a food source but also hold cultural and spiritual significance. The methods of preparation and the specific types of insects consumed are dictated by cultural beliefs and rituals, which underscores the importance of preserving these cultural practices for both biodiversity and cultural heritage conservation (Bukkens, 2022).

Meyer-Rochow (2009) highlighted the cultural diversity in entomophagy practices and emphasised how cultural norms and beliefs significantly influence the selection of insects for consumption and the methods of their preparation. Raubenheimer and Rothman (2013) analysed the nutritional aspects of insect consumption and how these are intertwined with cultural practices. They pointed out that cultural preferences often dictate which insects are considered edible and how they are prepared to optimise their nutritional value. For instance, in South American cultures, the preparation of ants and beetles involves specific cooking methods that enhance their palatability and nutritional content. This indicates that

cultural knowledge plays a crucial role in the dietary incorporation of insects, influenced by both taste preferences and nutritional benefits.

In various regions globally, certain communities rely on collecting, preparing, and selling wild insects as street food to sustain their livelihoods (Hawkey, 2021). In many rural communities that engage in entomophagy in developing nations, the use and trading of edible insects has long been a primary means of diversifying their sources of income. This may be due to the fact that entomophagy is a naturally occurring resource, requiring little to no technical expertise to collect and prepare for sale or consumption. Edible insects serve as the primary backup source of income in areas where entomophagy is practiced, protecting against erratic seasonal food shortages (Wade, 2020). Women and children frequently engage in the practice of collecting insects from the wild, particularly in rural areas where it serves as a source of income for the practitioners to improve their diets and pay for other necessities like food, education, and farm inputs, among other things (Wade, 2020).

## 2.6. Economic implications of edible insects

In addition to cultural and nutritional aspects, the consumption of GJBs may have economic implications for rural households in Limpopo Province. Entomophagy has been proposed as a sustainable solution to food insecurity, offering opportunities for income generation through insect farming and trade (Van Huis *et al.*, 2013). Understanding the economic dynamics of beetle consumption can shed light on its potential as a livelihood strategy for rural communities. Consuming and trading edible insects, particularly through street vending, helps those who are poor in rural areas of developing nations improve their standard of living and gain economic empowerment, particularly for women (Ghosh, 2019). This has a direct impact on achieving the first two Sustainable Development Goals (SDGs) set forth by the UN: zero hunger and zero poverty. Investigating several strategies to guarantee that rural households are food secure both now and in the future is necessary to address the current chronic food and nutrition security issues, such as hidden hunger. Van Huis *et al.* (2013) emphasised the economic opportunities associated with insect farming, highlighting the potential for small-scale farmers to generate income through the cultivation and sale of edible insects. Thus, entomophagy serves as a viable livelihood strategy, providing rural communities with an additional source of revenue in many regions.

## 2.7. Environmental considerations in the context of edible insects

In addition to their nutritional advantages, governments and organisations are promoting edible insects as a means of combating climate change. This is because they have been linked to lowering greenhouse gas emissions because they utilise organic waste (Hawkey, 2021). While entomophagy is often touted for its environmental sustainability compared to conventional livestock farming, it is essential to consider the ecological impact of harvesting GJBs. Overexploitation of insect populations can lead to environmental degradation and biodiversity loss (Gullan and Cranston, 2014). Therefore, sustainable harvesting practices and conservation efforts must be integrated into the consumption of GJBs to ensure longterm ecological balance.

Gullan and Cranston (2014) highlighted the importance of understanding the ecological roles of insects and the potential consequences of their exploitation. Insects, including beetles, play crucial roles in ecosystem functioning, such as pollination, nutrient cycling, and pest control. Therefore, the indiscriminate harvesting of GJBs without considering their ecological significance can disrupt ecosystem dynamics and lead to negative cascading effects on biodiversity and ecosystem services (Gullan and Cranston, 2014).

Feeding the world's expanding population puts strain on the planet's already finite resources, like land and water, which must be sustained through increased food production. There is a greater demand for food as the population grows, which could lead to environmental issues because there will be less space available for growing crops and rearing animals for food. If agricultural production remains unchanged, there is a chance that greenhouse gas emissions will rise and the environment would deteriorate, which can have a negative impact on food security, particularly food availability (Van Huis *et al.*, 2013). Alternative solutions for animal proteins must be adopted in order to address the existing high demand for animal proteins, which necessitates the large-scale rearing of animals over diminishing land resources (Omemo, 2021). It has been demonstrated that raising edible insects has a negligible environmental impact when compared to raising animals (Ancha, 2019), making it a better option for protecting the environment while also offering nutritional advantages.

## 2.8. Factors affecting the consumption of edible insects

There are a number of attributes that have been identified as potentially influencing the frequency and intake of edible insects. Manditsera *et al.* (2018) conducted a comprehensive study examining the consumption patterns of edible insects in Zimbabwe, focusing on both rural and urban populations. Their study utilised descriptive statistics to summarise the data, presenting findings such as the percentage of respondents consuming insects and the frequency of consumption. They further employed inferential statistical methods, including chi-square tests, to examine the relationship between demographic variables (for example, age, gender, location) and insect consumption patterns. Their findings revealed that 89.7% of rural respondents consumed insects, with 63.9% partaking more than three times a week. In contrast, 80% of urban respondents consumed insects, with only 14.5% doing so more than three times a week. The study highlighted that taste, nutritional value, and availability are key factors influencing the persistence of insect-eating habits.

Van Huis (2013) explored the potential of edible insects to enhance food security, particularly in sub-Saharan Africa. The author emphasised that insects are a rich source of protein, vitamins, and minerals, and their cultivation requires fewer resources compared to traditional livestock. This makes them a sustainable alternative for addressing nutritional deficiencies and ensuring food security in resource-limited settings. The author adopted a comprehensive literature review methodology to assess the role of edible insects in food security. By synthesising existing research, he identified the nutritional benefits of insects and proposed strategies for their integration into food systems. This method allowed for a broad understanding of the potential and challenges associated with entomophagy.

Meysing *et al.* (2021) investigated the contribution of edible insects to food and nutrition security in the Central Highlands of Madagascar. They conducted a survey among households in the rural commune of Sandrandahy, employing descriptive statistics, correlation, and regression analyses to assess the relative importance of insects in the local diet and to test various hypotheses related to food security. Their findings indicated that insects significantly contribute to animal protein consumption, especially during the humid season when other protein sources are scarce. Additionally, they observed that larger households tend to consume fewer insects per capita, suggesting that the total amount of insects collected is shared among more individuals, leading to reduced consumption per person.

Conversely, Omemo (2021) focused on entomophagy consumption patterns in western Kenya, examining the role of psychological and socio-cultural factors, which aimed to understand the factors driving insect consumption in the region. The study found that entomophagy is more common in larger families in Kenya, highlighting the influence of household size on the practice of consuming insects. This could be because more family members have more time to spend collecting insects in the wild, which increases the number of insects harvested (Durr and Ratompoarison, 2021). However, in Laos, the frequency of consuming edible insects differs by ethnicity (Barennes, 2015).

Because older people were more accustomed to consuming edible insects, there was a favorable correlation between age and intake in China (Liu *et al.*, 2020). By embracing Western cuisine and forsaking their cultural customs, young people in developing nations are gradually moving away from consuming insects (Vantomme, 2015; Hlongwane *et al.*, 2021). In Myanmar, however, some younger people are open to trying edible insects since they consider them a trendy food (Nischalke, 2020). People with less education were more likely to eat more insects because education was proven to be the best indicator of edible insect consumption in South Africa (Egan, 2013). But in Ghana, Anankware *et al.*, (2016) found a positive correlation between education and insect consumption, explaining that those with higher levels of education were more inclined to travel and be receptive to new experiences.

According to Carolyne (2018) and Manditsera *et al.* (2018), there is a negative correlation between income and the consumption of edible insects in Kenya and Zimbabwe. They also explained that people have more options for buying different animal proteins as their income increases. Because individuals can save money on food when insects are easily accessible, South Africans with lower incomes are likely to eat more edible insects (Egan, 2013). Similarly, because insects are harvested in the wild rather than bought, Durr and Ratompoarison (2021) observed no discernible differences in insect intake between wealthier and poorer families in the highlands of Madagascar.

In contrast, the frequency of consuming edible insects was unaffected by income in China and Kenya (Liu *et al.*, 2020; Carolyne, 2018). According to Hartmann *et al.* (2015), consumer approval is greatly influenced by familiarity. Higher acceptability of edible insects in Kenya was reported by those who were familiar with them (Pambo, 2016). Additionally, in Uganda, familiarity has a major impact on insect consumption (Olum, 2020). Accordingly,

being accustomed to a certain food type lessens anxiety and doubt over its consumption (Aldridge, 2009). People who are accustomed to consuming insects, for instance, consider them to be food (Schardong, 2019).

## 2.9. Summary of the literature reviewed

The reviewed literature revealed that indigenous communities in South Africa, such as the BaSotho and the San, have incorporated edible insects into their diets for both nutritional and cultural reasons. These edible insects have been recognised for their role as a traditional food source and their significance in cultural practices and medicine. Factors affecting insect consumption include socio-economic status, household size, education, familiarity with insects, and cultural attitudes. Lower-income individuals and those with less education were more likely to consume insects, partly due to their affordability. Conversely, higher income levels often correlate with reduced consumption as people opt for other animal proteins.

## CHAPTER THREE: RESEARCH METHODOLOGY

### 3.1. Introduction

The study's methodology is presented in this chapter. As a result, this chapter explains the area of study and the research methodology. The study area, data collection procedure, and analytical methodologies are the three subsections that make up this chapter.

### 3.2. Study area

The study was carried out in the Capricorn District of the Limpopo province specifically in the Lepelle-Nkumpi Local Municipality. According to the Limpopo Provincial Government (LPG, 2011), the province is an arid area with potential for food production. It includes the five district municipalities of Waterberg, Capricorn, Sekhukhune, Vhembe, and Mopani. Northern South Africa is home to the Capricorn District Municipality. The Tropic of Capricorn is the source of its name. Blouberg, Lepelle-Nkumpi, Molemole, and Polokwane are the four local municipalities that make up the Capricorn District Municipality, which is primarily pastoral in nature.

Lepelle-Nkumpi Local Municipality is located in the Capricorn District's southernmost region, and it is largely pastoral with a populace of roughly 233925 people. The municipality is distributed into 30 wards with a total of 61305 households and 94 villages/settlements (Stats SA, 2016). It covers 3464 hectares, which signifies 16 percent of the district's total terrestrial zone. Approximately 95 percent of the land falls under the power of traditional authorities. Agriculture, forestry, hunting, wholesale and retail, and personal services are the most important economic sectors in the region (Stats SA, 2016). In the Limpopo Province, insects are widely used as a supplementary protein source (Twine *et al.*, 2003). A study by Egan (2013) revealed that edible insects are one of the natural resources gathered in the Capricorn District, and indigenous knowledge about them exists but has not been previously documented.

Lepelle-Nkumpi is the most predominantly rural municipality, where household food security remains a pressing challenge (Lepelle-Nkumpi IDP, 2023). According to recent studies on rural livelihoods and food consumption patterns in Limpopo Province (for example, Van Huis, 2013; Manditsera *et al.*, 2018), rural households are more likely to engage in alternative food sources, including edible insects, due to limited access to conventional protein sources. Given that this study aims to assess the consumption of Giant-Jewel

Beetles among rural households, the municipality provides a relevant setting where such practices are likely to be observed and analysed. The municipality falls within the Savanna Biome, characterised by woody vegetation and acacia-dominated landscapes, which serve as natural habitats for various edible insect species, including Beetles (Scholtz and Chown, 1995). Studies on insect consumption in sub-Saharan Africa (for example, Musundire *et al.*, 2020) highlight those regions with dense woodlands and savanna ecosystems, such as those found in Lepelle-Nkumpi provide optimal habitats for various edible insect species.

### 3.3. Data collection

The study used primary data where purposive sampling and snowball sampling techniques were used to obtain data from rural households in the Lepelle-Nkumpi Local Municipality. In order to collect information from households through face-to-face interviews, a structured questionnaire was developed. The targeted respondent was the household head, which differed from household to household (i.e. female or male).

In this study, purposive sampling and snowball sampling were used to select the 3 villages from a total of 94 villages. Firstly, purposive sampling was applied to deliberately choose one village, Seleteng, based on specific criteria relevant to the research objectives, such as its demographic and ecological characteristics. After selecting Seleteng, snowball sampling was used to identify two additional villages, Maijane and Mamaolo. In this approach, community members from Seleteng referred these neighbouring villages, as they shared similar characteristics and were considered relevant to the study. Once the villages were selected, data were collected from 100 households across the three villages, ensuring a diverse and representative sample for the research.

#### 3.3.1. Sampling procedure

According to Stats SA (2016), the total households in the Lepelle-Nkumpi Local municipality is 61305. The sample size for this study was computed through a statistical approach by using the Slovin formula (Sugiyono, 2016). The formula is given as follows:

$$n = 1 \frac{N}{(e)^2} +$$

(e)<sub>2</sub> Where: n = sample size

N = total number of the households in the municipality

$e$  = sampling error, = 0.10

$$n = \frac{61305}{1 + 61305(0.10)^2}$$

$$n = 99.837$$

Therefore, the researcher interviewed 100 rural households in the Lepelle-Nkumpi Local Municipality from Seleteng, Maijane and Mamaolo villages. Due to an unknown number of consumers of GJBs, the study made use of both snowball and purposive sampling techniques.

Table 3.1: The sample sizes per village

<b>Village</b>	<b>Sample size used in the study</b>
Seleteng	26
Maijane	33
Mamaolo	41
<b>Total</b>	<b>100</b>

### 3.4. Analytical techniques

The study made use of descriptive statistics in the form of frequencies, mean and standard deviations to address objective one, which was to identify and describe the demographic information of rural households in Lepelle-Nkumpi Local Municipality, and objective two, which was to profile the consumption frequency of GJBs by rural households in LepelleNkumpi Local Municipality.

In order to analyse rural households' socio-economic factors that affect the consumption of GJBs within the study area, the study employed the Logistic Regression Model. The Logistic Regression Model is useful for determining the relationship between the dependent binary variable and the nominal, ordinal, interval, or ratio-level independent variables. According to Oni *et al.* (2018), the Logistic Regression Model is used in the calculation of dichotomous outcomes, because the dependent variable is not continuous; it takes the value of 0 or 1. Therefore the Logistic regression is suitable for this study because the dependent variable has two possible outcomes which are 0 and 1 where 1 represents the consumption of GJBs by rural households and 0 is the probability that rural households do not consume GJBs.

The general model:

$$L_i = \ln \left( \frac{Y_i}{1 - P_i} \right) = B_0 + B_1 X_1 + \dots + B_n X_n + e \quad (1)$$

Where:

$Y_i$  = Consumption of GJBs

$P_i$  = Probability that rural households consume GJBs

$1 - P_i$  = Probability that rural households do not consume GJBs

Table 3.2: Description of variables

Variable s	Code	Description	Measurement	Unit of measuremen t
<b>Dependent variable</b>				
Y <sub>i</sub>	CGJBs	Consumption of GJBs	1 if households consume GJBs, 0 otherwise	Dummy
<b>Independent variables</b>				
X <sub>1</sub>	GND	Gender	1 if the respondent is male, 0 otherwise	Dummy
X <sub>2</sub>	AGE	Age	0 if the respondent is 18 years to 25 years, 1 if the respondent is 26 years to 35, 2 if the respondent is above 35 years	Categorical
X <sub>3</sub>	LED	Level of education	0 if respondent has no formal education, 1 for primary, 2 for secondary, 3 for tertiary education.	Categorical
X <sub>4</sub>	HHS	Household size	Actual size	Numbers

X <sub>5</sub>	MRS	Marital status	0 if the respondent is single, 1 if married, 2 divorced, 3 if widowed.	Categorical
X <sub>6</sub>	RELI	Religion	1 if the respondent is a Christian, 0 otherwise	Dummy
X <sub>7</sub>	HINC	Household's income	Total household income	Rands
X <sub>8</sub>	SOIC	Source of household income	1 for Wages, 2 remittances, 3 social grants, 4 selfemployed, 5 other sources	Categorical
X <sub>9</sub>	EMP	Employment status	1 if the respondent is employed, 0 otherwise	Dummy
X <sub>10</sub>	CFRE	Consumption frequency during harvest season	0 if consumed one to two times a week, 1 if three to four times a week, 2 if consumed five-seven times a week	Categorical
X <sub>11</sub>	RFCN	Reason for consumption	0 if consumed for taste, 1 for nutrition, 2 for food option, 3 for medicinal properties	Categorical
X <sub>12</sub>	QCRC	Quantities consumed (250-300 ml cup)	0 if its 1 cup per week, 1 if its 2 cups per week, 2 if its more than 2 cups per week	Categorical
X <sub>13</sub>	MOTC	Method of consumption	0 if consumed as a relish, 1 if combined with other relish, 2 if consumed as a snack	Categorical
X <sub>14</sub>	PRIC	Potential risks of insect consumption	1 if there are potential risks associated with insect consumption, 0 otherwise	Dummy

### 3.5. Ethical considerations

The researcher applied for ethical clearance and approval from the Turfloop Research Ethics Committee (TREC) at the University of Limpopo prior to the commencement of the study. Subsequently, the ethical approval was granted (TREC/1657/2023:PG). Several ethical principles were adhered to during this study as guided by the TREC guidelines. For example, the respondents of this study participated on a voluntary basis and their responses are not traceable to individuals. The data collected is used for the purpose of the study only. The respondents were notified that they can withdraw from participating in the study whenever they felt like doing so. The study as well as its aim were explained to all respondents prior to the interviews, and they were informed that their participation will be kept anonymous and confidential. Furthermore, the researcher also asked permission to conduct the study in Ga- Mphahlele villages from the village local representative, which was the Nduna of the Lepelle-Nkumpi Local Municipality.

### 3.6. Chapter summary

The chapter provided an overview of the study's location. The location and population size of the study areas were indicated by a detailed description. The 100 households that took part in the study were selected using purposive and snowball sampling procedures. Structured questionnaires with both closed-ended and open-ended questions were used for face-to-face interviews. SPSS version 25.0 was used to analyse the data. Objectives one and two were addressed using descriptive statistics, and the Logistic Regression Model was used to address the third objective.

## CHAPTER FOUR: RESULTS AND DISCUSSION

### 4.1. Introduction

This chapter presents the descriptive results, where data on socio-economic characteristics collected from the 100 sampled rural households in Lepelle-Nkumpi Local Municipality, Limpopo Province are described. The results from the descriptive statistics in this chapter addressed the first objective on demographic information of rural households in the study area and the second objective, which profiles their consumption frequency of GJBs. This information is presented in graphs, figures and tabular forms. Results from the Logistic Regression Model are also presented. The Logistic Regression Model addressed the third objective of analysing the socio-economic factors that affect the consumption of GJBs in rural households.

### 4.2. Descriptive Statistics addressing demographic information of the rural households

Table 4.1: Descriptive statistics results for continuous variables (N=100)

<b>Variables</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Standard deviation</b>
Household size (Actual number)	1	8	4.19	1.686
Food expenditure (Rand)	900.00	5000.00	2678.00	966.780
Total household income (Rand)	2800.00	35000.00	12750.00	8249.353

Source: Survey results (2024)

The results presented in Table 4.1 indicate that households in the study area had an average of 4 members per household with the minimum and maximum of 1 and 8 members. The minimum amount spent on food per month was R900.00 while some households spent a maximum of R5000.00 per month. The average amount spent on food by each household was R2678.00 on a monthly basis. The maximum household income in the study area was R35000.00 while other households received a minimum of R2800.00 per month. A household is likely to have an average total household income of R12750.00 per month in the study area.

4.3. Gender of the respondents

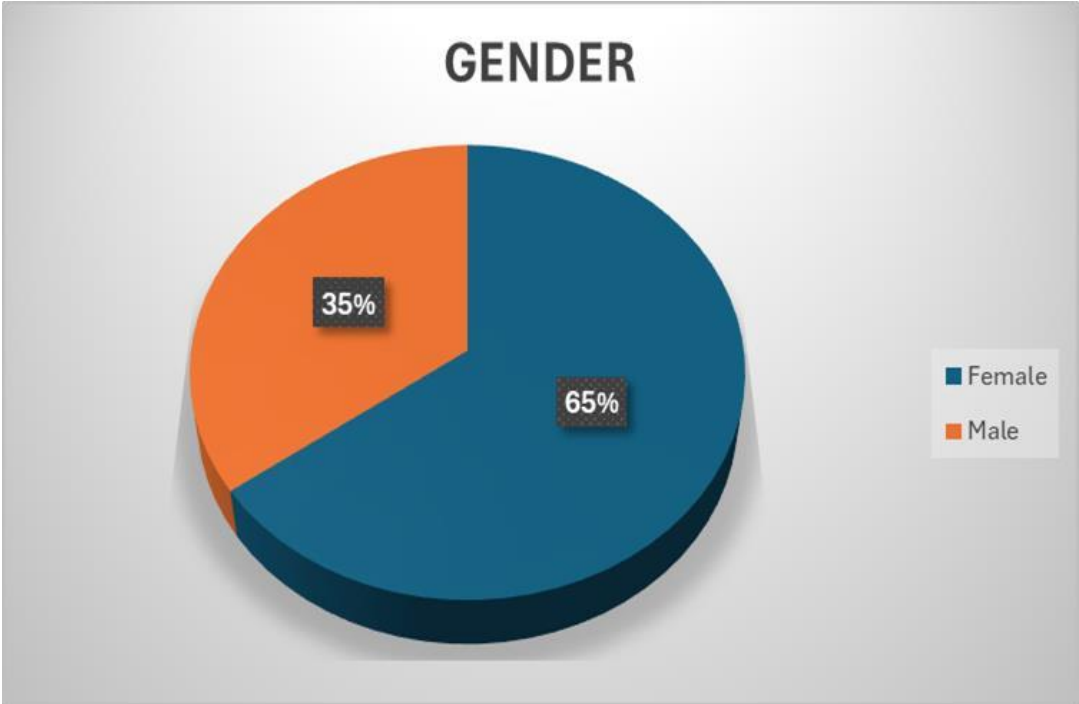


Figure 4.1: Gender of the respondents

Source: Survey results (2024)

Figure 4.1 indicates that 65% of the respondents in the study area were females while 35% were males. This highlights a higher representation of females in the study potentially suggesting a significant role they play in household food decision making. Females are often primary participants in surveys related to household management, or communitybased initiatives because they are typically more involved in domestic and subsistence activities (FAO, 2011).

4.4. Descriptive results for categorical socio-economic variables

Table 4.2: Descriptive results for categorical variables (N=100)

Variables	Frequency	Percentage (%)
<b>Age</b>		
18-25 years	7	7.0
26-35 years	29	29.0
Above 35 years	64	64.0

<b>Marital status</b>		
Single	38	38.0
Married	45	45.0
Divorced	4	4.0
Widowed	13	13.0
<b>Employment status</b>		
Employed	58	58.0
Unemployed	31	31.0
Self-employed	11	11.0
<b>Level of education</b>		
No formal education	4	4.0
Primary education	25	25.0
Secondary education	40	40.0
Tertiary education	31	31.0
<b>Source of income</b>		
Crafting	2	2.0
Farming	8	8.0
Pension	2	2.0
Remittances	11	11.0
Social grant	13	13.0
Self employed	5	5.0
Small business	7	7.0
Spousal allowance	1	1.0
Wages	51	51.0

Source: Survey results (2024)

Table 4.2 show that given a sample size of 100, the majority of the respondents (64.0%) were above 35 years of age, indicating that the study population skews towards older individuals. The smallest age group consisted of individuals aged between 18-25-year-old making up to 7.0% of the total sample. The 26-35-year-old group accounted for 29.0% of the respondents in the study area. Marital status was dominated by married respondents

(45.0%), followed by singles (38.0%). Widowed respondents made up of 13.0% of the respondents, while 4.0% were divorced. This indicates that the majority of the population is either married or single, with few divorced respondents. The relatively high number of married respondents (45%) points to an older demographic, as already noted in the age distribution. More than half (58.0%) of the respondents were employed, showing a reasonable level of employment. However, unemployment was presented as 31.0%, while only a small portion (11.0%) were self-employed. The highest proportion of respondents had completed secondary education (40.0%), followed by tertiary education (31.0%). Only (4.0%) had no formal education, while a quarter (25.0%) had only completed primary education. This indicates a relatively well-educated population, with a strong representation of respondents having at least a secondary level of education or higher. The primary source of income for over half of the respondents (51.0%) was wages, suggesting that many are either in formal or informal employment where they are paid regularly. Social grants (13.0%) and remittances (11.0%) also provide significant sources of income, which reflects some level of dependency on external financial support. Self-employment (5.0%), small businesses (7.0%), and farming (8.0%) were smaller but important sources of income. The low reliance on crafting (2.0%) and pensions (2.0%) indicates limited engagement in traditional or retirement income sources. According to International Labour Organisation (ILO, 2018), wages account for the largest share of income for most working-age populations, especially in regions with significant employment in formal and informal sectors.

4.5 Households consumption of GJBs

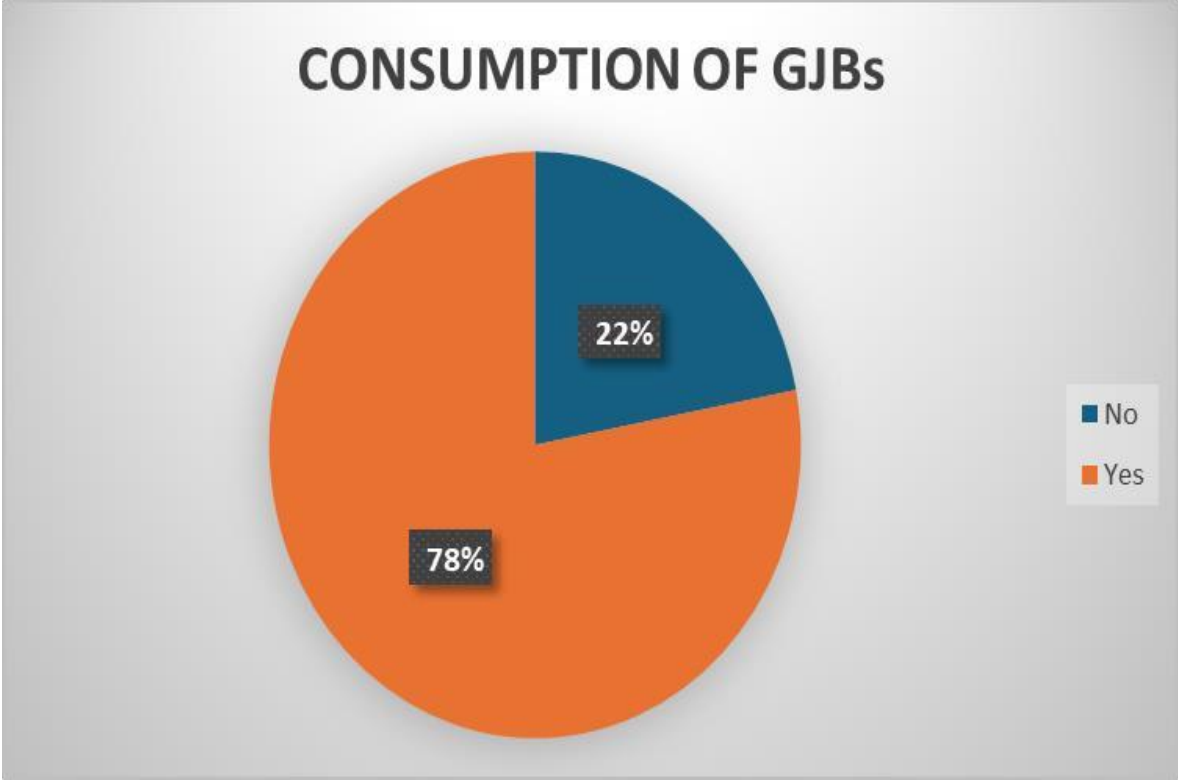


Figure 4.2: Consumption of GJBs

Source: Survey results (2024)

Figure 4.2 shows that 78% of the respondents consumed GJBs while only 22% of the respondents did not consume them. This indicates a high level of consumption preference among the households in the study area suggesting that GJBs are commonly regarded as food. Van Huis *et al.* (2013) highlighted that beetles are one of the most widely consumed insect groups globally, and their consumption is often associated with traditional practices.

4.6. Reasons for consumption of GJBs

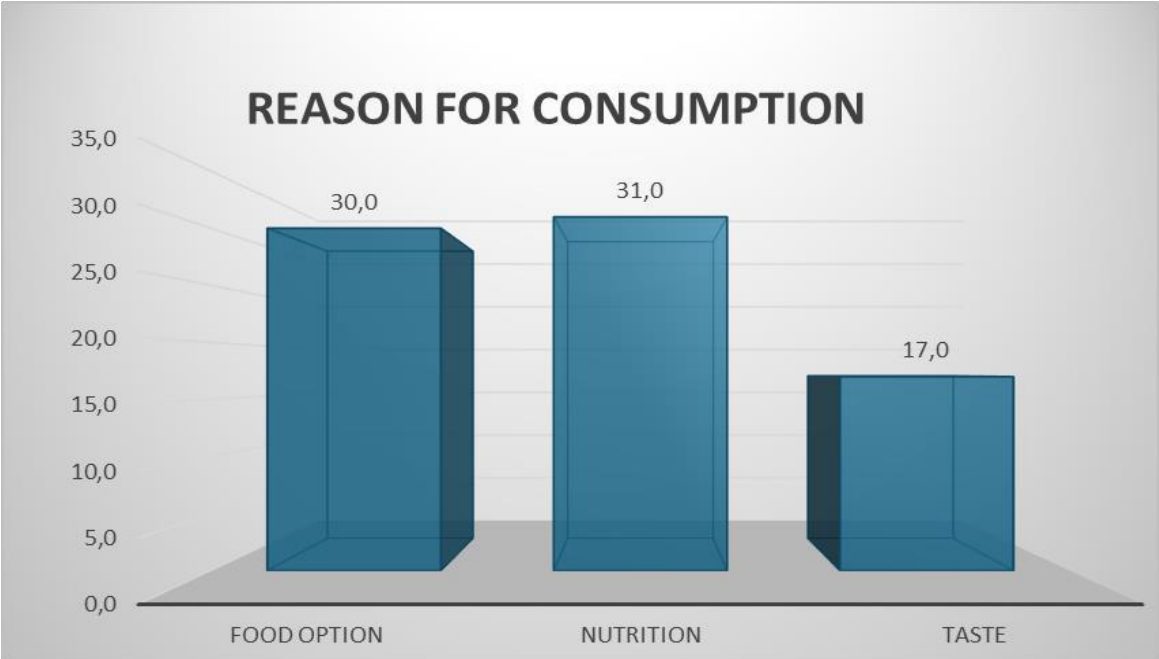


Figure 4.3: Reasons for consuming GJBs

Source: Survey results (2024)

The results presented in Figure 4.3 indicates that 30% of the households consumed GJBs because it is regarded as a food option. About 31% of the households consume GJBs for its nutritional composition. Only 17% of the households consume GJBs for their taste. Tan (2016) explored consumer perceptions of insect-based food in various regions, finding that taste is often a barrier to insect consumption for many people. While a minority of households appreciated the taste of GJBs, a larger proportion consumed these insects for their nutritional benefits.

4.7. Consumption methods of GJBs

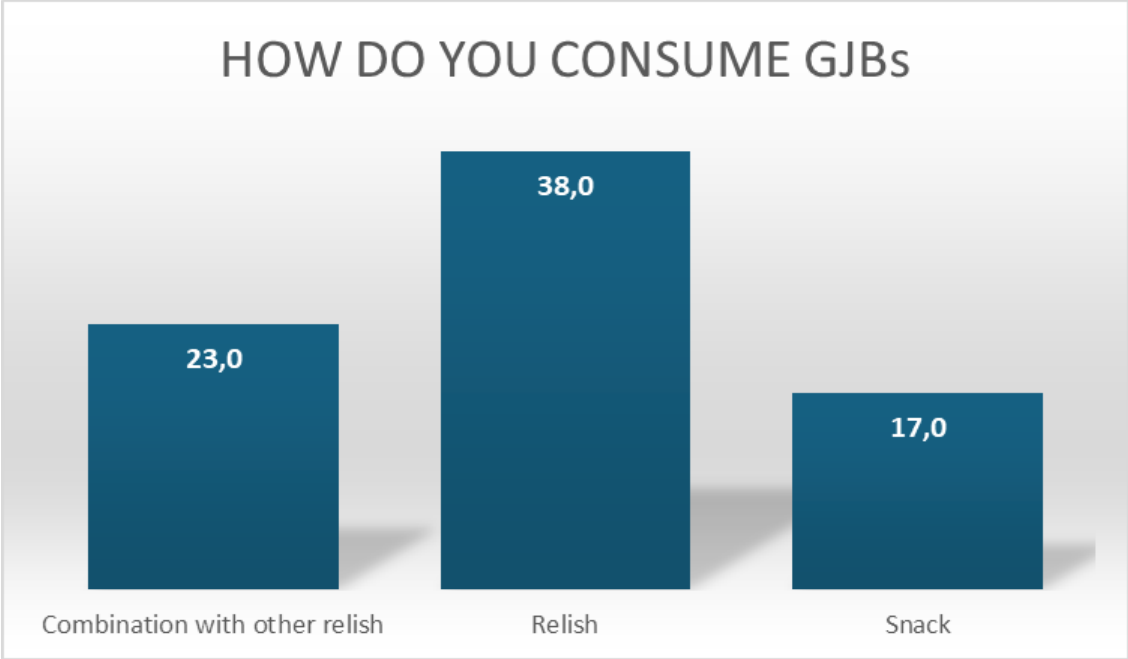


Figure 4.4: Consumption methods of GJBs

Source: Survey results (2024)

According to Figure 4.4, the majority of the households (38%) consume GJBs as a relish, and only 17% consume them as a snack. About 23% of the households mentioned that they combine the GJBs with other forms of relish during consumption. Finke (2021) highlighted that edible insect, such as beetles, are often consumed in various forms, including as part of main dishes, snacks, or as one of the ingredients when preparing certain food.

#### 4.8. Market place for purchasing GJBs



Figure 4.5: Market place for purchasing GJBs

Source: Survey results (2024)

The results as indicated in Figure 4.5 shows the marketplace where households in the study area buy GJBs. As a result, 44% of the households mentioned that they buy the GJBs from street vendors, while some (12%) harvest them by themselves, and 22% of the households buy them from the local shops. Sogari (2019) explored the supply chain and consumer behaviour related to edible insects revealed that while some consumers prefer to harvest insects themselves, most of them relied on local vendors for convenience and consistent supply.

#### 4.9. Descriptive results profiling the consumption frequency of GJBs

Table 4.3: Descriptive statistics results for profiling the consumption frequency of GJBs

<b>Variables</b>	<b>Frequency</b>	<b>Percentage (%)</b>
<b>Consumption frequency</b>		
1-2 times a week	44	44.0
2-4 times a week	1	1.0
3-4 times a week	23	23.0
5-7 times a week	10	10.0
<b>Quantities consumed</b>		
2 cups per week	40	40.0
1 cup per week	9	9.0
More than 2 cups per week	29	29.0
<b>Who consumes Giant-Jewel Beetles</b>		
All household members	12	12.0
Me and my mother	2	2.0
Me and my children	9	9.0
Me and my parents	2	2.0
Me and my siblings	4	4.0
Me and my spouse	18	18.0
My parents only	1	1.0
My siblings only	2	2.0
Household food preparer	27	27.0

Source: Survey results (2024)

The results indicate that a majority of respondents (44.0%) consumed GJBs 1-2 times a week, which suggests that this consumption frequency is the most common practice in the study area. A smaller group (23.0%), consumed GJBs 3-4 times a week. Conversely, the low percentage of respondents (1.0%) who consumed GJBs 2-4 times a week, highlights that this specific consumption rate is not typical. The findings of the study are in line with Finke (2021) who found that edible insects are commonly consumed as a regular dietary

component in regions where they are culturally accepted, for instance, in parts of Africa and Asia where households often rely on insects several times a week for their nutritional value.

The data also revealed that (10.0%) of the respondents consumed GJBs 5-7 times a week. In terms of quantities consumed, (40.0%) of the respondents reported consuming 2 cups of GJBs per week, reflecting a moderate level of intake that aligns with the consumption frequency. Additionally, about 29.0% of the respondents indicated that they consumed more than 2 cups per week. Only 9.0% reported consuming 1 cup per week, suggesting that a small proportion consumes just one cup, while the majority (about 69%) consume two cups or more per week. According to Table 4.3, respondents about 27.0% consumed GJBs solely on their own. In contrast, only 12.0% of respondents consumed GJBs with all family members. The data shows that consumption often occurs within smaller, immediate family members, consuming with a spouse and smaller percentages involving children, parents, or siblings accounted for 9.0%, 1.0%, 2.0% and 18.0% respectively. Hartmann *et al.*, (2015) found that insect consumption patterns are often influenced by household roles, with food preparers or decision makers frequently playing an important role in their inclusion of meals.

#### 4.10. Logistic regression results for the socio-economic factors

The Logistic Regression Model was used to analyse rural household's socio-economic factors that affect the consumption of GJBs in the study area. This section provides insights into the socio-economic factors influencing the consumption of GJBs.

Table 4.4. The Logistic Regression Model Results

<b>Variables</b>	<b>B</b>	<b>Standard error</b>	<b>Wald</b>	<b>Significance level</b>
Constant	-12.088	7.745	2.436	0.119
Gender	0.968	1.193	0.659	0.417
Age	1.884	0.984	3.668	0.055*
Marital status	-0.543	0.72	0.568	0.451
Household size	0.189	0.377	0.253	0.615
Level of education	0.366	0.727	0.254	0.614
Source of income	-0.112	0.26	0.185	0.667
Food expenditure	-0.002	0.001	5.42	0.020**
Consumers of GJBS in the household	-0.397	0.196	4.125	0.042**
Where do you buy GJBS	-0.640	0.5	1.637	0.201
Potential risks associated with insect consumption	4.930	2.015	5.985	0.014**
Benefits associated with insect consumption	0.014	0.128	0.013	0.910
How do you consume GJBS	0.743	0.564	1.731	0.188
Reason for consumption	1.007	0.582	2.995	0.084*
Insect stigmatisation	0.333	1.098	0.092	0.762
How often GJBs are consumed	1.801	0.715	6.341	0.012**

-2 log likelihood: 41.724

Chi squared: 63.658

Cox and Snell R-square: 47.1%

Nagelkerke R-square: 72.3%

\*\*\*, \*\*, \* represent 1% level of significance, 5% level of significance and 10% level of significance respectively.

Source: SPSS

Table 4.4. indicates that six variables (i.e. age, food expenditure, consumption reason, potential risks, how often GJBs are consumed, and consumers of GJBs in the household) out of fifteen variables that were regressed were significant in affecting the consumption of GJBs in the study area. The model's Nagelkerke R square is 72.3%. Since the independent variables accounted for roughly 72.3% of the variation in the dependent variable and the unknown variables for the remaining 27.2%, the Nagelkerke R square indicates that the model fit is good. There is a 41% possibility that the variables in the model will be mispredicted, according to the model's likelihood of 41.724.

#### 4.2.1. Age

Age was statistically significant at 10% level and was found to have a positive influence on the consumption of edible insects (GJBs), indicating that older individuals are more likely to consume GJBs. The study results found that 64% of the respondents who were above the ages of 35 years consumed GJBs than those that were below the age of 35 years. Liu *et al.*, (2020) also found age to be positively correlated with the consumption of edible insects. The findings of this study concurred with Hlongwane *et al.* (2021) by suggesting that young people are increasingly turning away from insect eating practices. However, Nischalke (2020) indicates that young people in countries such as Myanmar view edible insects as trendy food and are willing to participate in insect practices.

#### 4.2.2. Food expenditure

The amount of money that the respondents spent on food on a monthly basis was statistically significant at 5% and was found to have a negative effect on the consumption of GJBs. This implies that consumption of GJB is likely to decrease as respondents spend more money on food. Studies by Van Huis (2021) and Mancini *et al.*, (2019) have found similar results, where higher food expenditure reduces reliance on alternative proteins like insects, which are often perceived as food for lower-income groups. In contrast, Rumpold and Schluter (2013) argued that higher awareness of sustainability and nutrition could lead

wealthier individuals to consume more edible insects, as these are often marketed as environmentally friendly options.

#### 4.2.3. Consumers of GJBs in the household

The variable consumers of GJBs in a household was found to be statistically and negatively significant at 5% level. This implies that the presence of few consumers of GJBs in the household decreases the likelihood of the whole households to consume these insects. The findings of the study are in line with Verbeke (2015) who found that household influence can lead to a negative outcome for the consumption of novel food and the familiarity within a household can reduce the appeal of food. Hartmann *et al.*, (2015) concurs with the study by suggesting that households with more consumers of alternative proteins often increase individual consumption through familiarity and reduced stigma.

#### 4.2.4. Potential risks associated with insect consumption

The risks associated with insect consumption was statistically and positively significant at 5% level with the consumption of GJBs. This implies that concerns over the potential risks associated with insect consumption significantly increases the likelihood of GJBs consumption. This further suggests that respondents who are aware of the risks associated with insect consumption might increase their consumption of edible insects. Van Huis *et al.*, (2021) discussed how heightened awareness of the risks can sometimes increase the interest in novel food because people become more informed to make decisions about the food they can consume. However, Fernandez *et al.*, (2020) argued that the risk perception typically decreases the likelihood of insect consumption as people tend to avoid food they perceive as being risky.

#### 4.2.5. Reason for consumption

The reasons for consumption of edible insects like the GJBs, was statistically significant at 10% level with a positive coefficient of 1.007. The study showed that the respondents consumed edible insects for their nutritional benefits and also as a food option. The findings of the study are in line with Van Huis *et al.*, (2021) who agrees that nutritional benefits are a key driver for the consumption of edible insects. The author stated that consumers who recognise the nutritional benefits of edible insects, particularly their high protein content and essential amino acids, are more likely to incorporate them into their diet.

#### 4.2.6. How often GJBs are consumed

Consumption frequency of GJBs was found to be significant at 5% level with a positive coefficient (1.801), indicating that more frequent consumption is associated with a higher likelihood of consuming GJBs, supporting the idea that familiarity leads to increased acceptance and consumption (Hartmann *et al.*, 2015). Sogari (2019) examined the relationship between familiarity and acceptance of edible insects among consumers in Europe. The findings highlighted that those respondents who had previous exposure to or experience with consuming insects were more likely to include them in their diet.

#### 4.2.7. Insignificant variables

The results from the Logistic Regression Model indicate that nine out of fifteen variables were insignificant. The insignificant variables of the model include gender, level of education, source of income, marital status, household size, insect stigmatisation, how GJBs are consumed, where GJBs are bought and benefits associated with the consumption of GJBs. Although the study's significant variables are more important than these variables, this does not imply that the variables are unimportant. Due to the lack of evidence supporting their impact on the consumption of edible insects in the study area, the variables are not significant.

#### 4.2.8. Chapter summary

This chapter revealed the factors affecting the consumption of edible insects in the study area, using the Descriptive statistics and the Logistic Regression Model. The descriptive results for the demographic characteristics showed that most respondents were above the age of 35 years and the majority (65%) of the respondents were females with 45% married and 38% single. The descriptive results for consumption frequency of GJBs showed that majority (44%) of the respondents consumed GJBs 1-2 times a week while only 1% consumed them 2-4 times a week. The Logistic Regression Model results also provided the factors that affect the consumption of GJBs.

## CHAPTER FIVE: SUMMARY, CONCLUSION, RECOMMENDATIONS

### 5.1. Introduction

The study's key findings are presented in this chapter, along with a summary of the findings' discussion and a conclusion drawn from the study's descriptive and empirical analyses. In light of the study's conclusions, this chapter provides recommendations.

### 5.2. Summary

The study was conducted under the Lepelle-Nkumpi Local Municipality in the Capricorn District. The purpose of the study was to assess the consumption of GJBs (*Sternocera Orissa*) among rural households in the study area. The three objectives of the study were to identify and describe the demographic information of rural households, profile the consumption frequency of GJBs by rural households and lastly to analyse the rural household's socio-economic factors that affect the consumption of GJBs in Lepelle-Nkumpi Local Municipality of Limpopo Province. The study had only one hypothesis, which posited that socio-economic factors such as age, gender and household size do not affect the consumption of GJBs in the study area.

Descriptive statistics was used to identify and describe the demographic information of rural households, and also to profile the consumption frequency of GJBs by rural households in the study area. The descriptive results for the demographic characteristics showed that most of the respondents were above the age of 35 years and the majority (65%) of the respondents were females with 45% being married while 4% were divorced. The descriptive results for the demographic characteristics also showed that 40% of the respondents had secondary education while 4% had no formal education. The employment status shows that 58% of the respondents were employed while 31% were unemployed and the majority of the sampled respondents (51%) had wages as their source of income. The minimum amount that each household spent on food was R900.00 with a minimum household income of R2800.00. The average amount that the households spent on food was R2950.00.

The descriptive results on the consumption frequency of GJBs showed that most of the households (44%) consumed GJBs 1-2 times a week while only 1% consumed them 2-4 times a week with 30% of the households consuming the GJBs as a food option and 17% consuming them for taste. The descriptive results also showed that 38% of the households consumed the GJBs as a relish and 23% combined the GJBs with other relish. About 44%

of the households harvested the GJBs by themselves while 12% bought them from the street vendors, and each household (40%) consumed 2 cups of the GJBs on a weekly basis.

The Logistic Regression Model was used to analyse the rural household's socio-economic factors that affect the consumption of GJBs in the study area. The results from the Logistic Regression Model provided insights into the factors influencing the consumption of GJBs in the study area, with six out of fifteen variables being significant. The significant variables were age, food expenditure, consumers of GJBs, potential risks associated with insect consumption, reason for consumption, and how often GJBs are consumed. These significant variables explain 72.3% of the variation in the dependent variable, as indicated by the Nagelkerke R square, showing that the model has a good fit. Food Expenditure had a negative coefficient (-0.002) suggesting that as food expenditure increases, the likelihood of consuming GJBs decreases. The results also showed that older individuals (above 35 years) are more likely to consume GJBs. Nine variables, including level of education, marital status, source of income, gender, and household size, were found to be insignificant.

### 5.3. Conclusion

The study proposed only one hypothesis to predict the outcome. The hypothesis was that socio-economic factors such as age, gender and household size do not affect the consumption of GJBs in Lepelle-Nkumpi Local Municipality of Limpopo Province. The hypothesis was rejected because the Logistic Regression results indicate that factors such as age, consumption reason and food expenditure influence the consumption of GJBs in the study area.

### 5.4. Recommendations

Based on the findings of the study, several policy recommendations can be made to the Ministries of Health and Nutrition from the Local and National Government to promote the consumption of edible insects, particularly GJBs, and to address the socio-economic factors that influence insect consumption among rural households.

Given the global focus on sustainability, and the potential of edible insects to serve as a low-environmental-impact food source, policymakers should promote GJBs and other edible insects as environmentally friendly alternatives to conventional animal protein, especially in rural households. The results indicated that higher food expenditure was

negatively associated with the consumption of GJBs, suggesting that as households spend more on food, they are less reliant on alternative proteins such as insects. To counteract this trend and increase the availability of affordable insect-based protein, government agencies should provide financial support to small-scale insect farmers in a way of offering grants or subsidies to help them cover start-up costs such as setting up insect rearing facilities. In addition, policymakers can facilitate the creation of local value chains for edible insects by supporting the development of infrastructure for packaging, processing and distribution. Partnerships with local street vendors can ensure that GJBs are accessible to rural households and affordable for low-income communities.

The study also found that concerns over potential risks associated with insect consumption were positively correlated with higher consumption of GJBs, implying that risk awareness could lead to more informed choices. However, to ensure consumer confidence and safety, policymakers should prioritise the development and enforcement of food safety standards for edible insects. This would involve establishing clear regulations on the harvesting, and processing of insects to mitigate health risks and ensure product quality. Moreover, risk communication strategies should be implemented to educate consumers about the safety of consuming edible insects, including addressing concerns related to allergies, contaminants, and proper preparation methods.

#### 5.5. Area for further study

While this study has provided valuable insights into the socio-economic factors affecting the consumption of GJBs among rural households, there are other important and relevant issues that are not addressed in this study. Hence, there are areas for further research that need to be considered:

- Further research is needed to assess the economic viability of insect farming as a livelihood option in rural areas.
- Further research could also explore how specific sensory attributes (e.g., taste, texture, and appearance) influence consumer preferences for edible insects, particularly in relation to GJBs.

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## APPENDIX 1: QUESTIONNAIRE



Name of researcher: Ntsoane Mahlogonolo Ramatsimele

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Research topic

ASSESSING THE CONSUMPTION OF GIANT-JEWEL BEETLES (STERNOCERA ARISSA) AMONG RURAL HOUSEHOLD IN THE LEPELLE-NKUMPI LOCAL MUNICIPALITY OF LIMPOPO PROVINCE.

Aim of the study

The aim of the study is to assess the consumption of Giant-jewel beetles as edible insects by rural households in Lepelle-Nkumpi Local Municipality of Limpopo Province.

The objectives of the study are:

- i. To identify and describe the demographic information of rural households in LepelleNkumpi Local Municipality.

ii. To profile the consumption frequency of Giant-Jewel beetles by rural households in Lepelle-Nkumpi Local Municipality. iii. To analyse the rural household's socio-economic factors that affect the consumption of Giant-jewel beetles in rural households.

**SECTION A: DEMOGRAPHIC INFORMATION**

1. Kindly provide your age (in years):

18-25 years	26-35 years	Above 35 years
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2. What is your gender?

Female	Male
--------	------

3. What is your marital status?

Single	Divorced
Married	Widow

4. What is your employment status?

Employed	Unemployed
----------	------------

5. What is your religion? (specify).....

6. How many are you at home? (household's size) specify.....

7. What is your highest level of education?

No formal education	Primary education
Secondary education	Tertiary education

8. What is your source of income?

Wages	Social grant
Remittances	Self-employed
Other source of income (please specify) .....	

9. How much do you receive monthly? (In rands) .....

10. How much do you spend on food per month? (in rands) .....

**SECTION B: INSECT CONSUMPTION PRACTICES**

1. Have you ever consumed insects as part of your diet?

Yes	No
-----	----

2. Which of the following insects have you consumed before:

Locust	Crickets	Mealworms
Mopani worms	Stink bugs	Ants
Termites	Grasshoppers	Other (please specify)

3. What benefits do you associate with consuming insects as a source of food?

Environmental sustainability	Cultural reasons
Nutritional value	Other (please specify)

4. Has incorporating insects into your diet positively affected your lifestyle or wellbeing?

Yes	No
-----	----

if yes, please explain: ....

5. Are you concerned about potential risks or harms associated with consuming insects?

Yes	No
-----	----

If yes, which of the following potential risks concerns you?

Allergic reaction	Digestive issues	Psychological discomfort	Misidentification of edible insects
Contamination	Chocking	Unpleasant taste/odour	Other (please specify)

6. Have you ever felt stigmatised or judged for eating insects?

Yes	No
-----	----

If yes, can you provide examples why you felt stigmatised or judged due to insect consumption? Choose from the list below

Poverty	Religion/cultural practice	Health problems
Unemployment	Old-age practice	Mental problems

## SECTION C: CONSUMPTION OF GIANT JEWEL BEETLES

1. Do you consume Giant-Jewel beetles?

Yes	No
-----	----

2. If you responded yes to the above question, how often do you consume giant jewel beetles during the harvest season?

1-2 times a week	3-4 times a week	5-7 times a week
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3. What is your reason for consumption?

Taste	Medicinal purpose
Nutrition	Food option

4. How do you consume giant jewel beetles?

Snack	Relish	Combination with other relish
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5. Where do you buy the giant jewel beetles?

Street vendors	Local shops	Specify if other
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6. Quantities consumed.

1 cup (250-300 ml) per week	2 cups (250-300 ml) per week	More than 2 cups (250-300 ml) per week
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7. Who consume Giant-Jewel Beetles in your household?

Only me	Me and my children	Me and my spouse	My spouse only
My children only	My siblings only	My parents only	Other (please specify)

Thank you for participating in this study.



## APPENDIX 2: CONSENT FORM

Name of researcher: Ntsoane Mahlogonolo Ramatsimele

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Cosupervisor: Dr JP Mokhaukhau

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Research topic: Assessing the consumption of Giant-Jewel beetles (*Sternocerra Arissa*) among rural households in the Lepelle Nkumpi Local Municipality of Limpopo province.

Ethical considerations:

The respondents of this study will participate on a voluntary basis and their responses will be kept confidential, their names will not be recorded on the questionnaire, and their responses will only be seen by the researcher. The data collected will be used for the purpose of the study only. The respondents will be notified that they can withdraw from participating in the study whenever they feel like doing so. The study as well as its aim will be explained to all respondents, and they will be informed that their participation shall be kept anonymous and confidential. The study would not be of any harm to the respondents.

Consent:

I have read the above information relating to the research and have also heard the verbal version and declared that I understand it. With this understanding, I agree to participate

Signature: .....

Date: .....

Village: .....

### APPENDIX 3: LETTER OF APPROVAL

Name of researcher: Ntsoane Mahlogonolo Ramatsimele

Supervisor: Prof MP Senyolo

Cosupervisor: Dr JP Mokhaukhau

Contact details: [mramatsimele71@gmail.com](mailto:mramatsimele71@gmail.com)/ 0828834541

School of Agricultural and Environmental Sciences

University of Limpopo

Dear Chief/Nduna

Subject: Request for Research study Approval

I hope this letter finds you well, I am writing to seek approval for conducting a research study within our village. The study aims to assess the consumption of Giant-Jewel Beetles (*Sternocera Arissa*) among rural household in the Lepelle-Nkumpi Local Municipality of Limpopo Province.

I assure you that the research will adhere to ethical guidelines, and measures will be taken to minimise any inconvenience to the community members. Additionally, I am committed to sharing the findings with the village and ensuring transparency throughout the process.

I kindly request a meeting at your earliest convenience to discuss this matter further and address any concerns you may have. Your support is crucial for the success of this research, and I am eager to contribute valuable insights to the betterment of our community.

Thank you for considering my request. I look forward to your positive response.

Sincerely

Ntsoane Mahlogonolo Ramatsimele