EVALUATION OF THE HARVESTING AND MARKETING OF MOPANE WORMS AND ITS EFFECT ON THE INCOME AND DIETARY DIVERSITY OF HOUSEHOLDS: A CASE STUDY OF MWENEZI DISTRICT, ZIMBABWE

A dissertation submitted in partial fulfilment of the requirements for the Master of Science Degree in Food Security and Sustainable Agriculture

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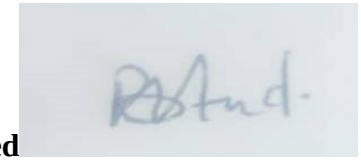
Signed 

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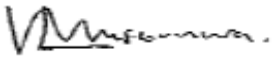
Signature: 

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DECLARATION

I hereby declare that the research project entitled "**Evaluation of the harvesting and marketing of mopane worms and its effect on the income and dietary diversity of households: A case study of Mwenezi District, Zimbabwe**" submitted to Bindura University of Science Education, Department of Agricultural Economics, Education and Extension is a record of an original work done by me under the guidance and supervision of **Dr L. Musemwa** and this work is submitted in partial fulfilment of the requirements for the award of a Master of Science Degree in Food Security and Sustainable Agriculture. The results embodied in this thesis have not been submitted to any University or Institute for the award of any degree of diploma.

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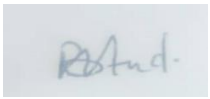
Signature: 

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DEDICATION

I dedicate this masterpiece of work to my two daughters, Anotidaishe and Atipaishe. Furthermore, to my encouraging and above the rest, supporting mother, Sonia Mhuri.

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Abstract

For centuries, nontimber forest products have been key aspects of household diets throughout the world. In Southern Africa, mopane worms are widely harvested for household consumption and traded for income generation at the same time contributing immensely to household food security. This study evaluated the harvesting and marketing of mopane worms and its' effects on household income levels and household dietary diversity in Mwenezi district, Masvingo Province, Zimbabwe. The research was conducted in the 15 villages of ward 15 of Mwenezi District. The study employed qualitative methods to collect data and included semi-structured household interviews. The respondents were identified through snowball sampling techniques. The significance of mopane worms in the study area is three-fold: it is an important source of food, it is a valuable trading commodity, and it is an intrinsic part of local cultural practices. The findings of this study indicated that the historical value placed on mopane worms as a food source and trading commodity had been passed down for generations. The most prominent method of mopane harvesting is shaking of the trees for the worms to fall then pick into sacks and baskets. The least method is cutting down of the trees. The main harvesting period when the mopane worm is fully matured is normally from February to March. Women constitute the majority who do the harvesting of the worms with the least done by boys. Women and girls are mainly responsible for processing of the worms including drying. Most of the mopane worm harvesters sell locally to mainly the middlemen as this have the minimum possible marketing costs. Most of the mopane harvesters are price takers as the marketing options are limited by transport network and availability to access high value markets. The average price off taker price is ZAR300/ bucket. The incomes from the sale of mopane worms ranged from ZAR300 to ZAR4800 and an average ZAR2409 per season. Mopane worm harvester have comparatively higher incomes when compared to none- harvesters and the differences in income levels are statistically significant. The dietary diversities of those harvesting mopane worms are generally higher than the non- harvesters. Mopane harvesters have more meal frequencies when compared to non- harvesters. Mopane harvesters employ lesser number of coping strategies in response to shortages of food at household level. There is need to develop policies that help educate the community with regards to utilisation of natural resources to avoid depletion of the mopane parent stock. In addition, mopane worm harvesters need to be trained on marketing, financial inclusion, value addition and environmental protection issues.

Keywords: Nontimber forest products, employment, food security, household dietary diversity, income, mopane worms.

LIST OF ACRONYMS AND ABBREVIATIONS

MW	Mopane Worm
EA	Enumeration Area
FGD	Focus Group Discussion
HDDS	Household Dietary Diversity Score
RLS	Rural Livelihood Assessment
ZIMVAC	Zimbabwe Vulnerability Assessment Committee

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CHAPTER 1
INTRODUCTION

1.1 Background of the study

Mopane worm is a colloquial name of the caterpillar of the emperor moth, *Imbrasia belina* (Makhado, et al., 2009), which feeds predominantly on the leaves of the mopane tree (Dube & Dube, 2010). Because of its high dependence on the mopane tree, the caterpillar is mostly found within the geographical range of *Colophospermum mopane* (Illgner & Nel, 2000). The caterpillar is widely consumed by rural and urban households within southern Africa, and due to its nutritional value and popularity, harvesting has been increasing and changing from a subsistence livelihood activity to a commercial one (Kozanayi & Frost, 2002; Thomas, 2013). The caterpillar outbreaks occur in two periods, the first from December to January, and the second from April to May (Makhado, et al., 2014). For rural and unemployed people, the two outbreaks create seasonal employment or income generating opportunities during the harvesting season and the subsequent trade (Makhado, et al., 2014). Originally, the mopane worm used to be an important food source for the rural communities occurring within the range of mopane woodland, but it is now widely eaten across Zimbabwe where it has become an important trading commodity. Mopane worms have a high protein content and are considered a traditional delicacy. Women and children are usually involved in Mopane worm collection but in recent years men and youth have participated in the gathering of this product, attracted by the income earning opportunities from the supply and trading of Mopane worms. The precise contributions of mopane worm to the livelihoods of rural people are not well understood in terms of the social and economic categories of people engaged in harvesting, processing, trading, and consuming mopane worms. Of particular concern is the need to understand what opportunities and constraints there are for enhanced but sustainable use of mopane worms, and how people might be able to derive more value from the resource and their use over time.

Whereas harvesting of mopane worms was traditionally a subsistence livelihood activity, undertaken largely for nutritional purposes, increasing commercialisation of the resource has been taking place in recent years (Hobane, 1994, 1995; Rebe, 1999). Mopane worms are being increasingly widely traded throughout Southern Africa, with evidence of marketing chains extending from southern Zimbabwe and eastern Botswana to South Africa, Zambia and the Democratic Republic of the Congo, as well as regionally within the main producing countries

(Botswana, Namibia, South Africa and Zimbabwe). Despite this, there has been little research on the nature and dynamics of the marketing chains, markets or the traders involved.

There are several ways being used to harvest Mopane worms, including, waiting for the worms to climb down the Mopane trees and collectors pick them up, climbing the Mopane trees and pick up them and cutting down the Mopane trees and then pick up the worms, not leaving shacking rigorously the Mopane trees and the worms fall and get picked. In the process, unsustainable ways are used, including the cutting down of the Mopane trees. The handling of the Mopane worms during harvesting suggests several food safety and hygiene short comings which could affect the marketing potential of the Mopane worms to elite markets. The marketing of Mopane worms is at local level, that is within the district of Mwenezi (trading points, local institutions, passer-by), across Zimbabwe provinces and exporting to South Africa and Botswana though mostly using informal illegal marketing channels and routes. Packaging of the Mopane worms during marketing leaves a lot to be desired as some is traded in open buckets, dirty 50kg sacks and even open plastics.

The contribution of Mopane worms to household food and nutrition security and income generation among the people of Mwenezi district also requires a closer look to determine the level and extend of these benefits. Hence the aim of these study is to evaluate the harvesting processes of Mopane worms, analyse the marketing processes currently used and determine the level of sustainability, effectiveness, and impact in regard to household income generation from Mopane worms and also to evaluate the household food security through investigating the household nutrition contribution of Mopane worms to harvesters and non-harvesters of the Mopane worms in Rutenga, Mwenezi district.

1.2 Problem statement

Rural households are vulnerable to food and income adversity (Baiyegunhi, Oppong & Senyolo, 2016). As a result, they adopt a range of livelihoods strategies, including consumption and trade of woodland resources to improve their living standards. Whilst Mopane worms may contribute to food security, this safety net function needs more critical and quantitative investigation. While deforestation and extreme changes in both rainfall and temperature are known to influence Mopane worm outbreak events and availability (Dube & Phiri, 2013), the impact of these factors in the context of harvesters and traders in Mwenezi District, Zimbabwe has not received in-depth attention. Child undernutrition remains a major public health problem

in developing countries leading to morbidity and mortality among children under five years. Child stunting, defined as a situation when a child is too short for his or her age is the main form of undernutrition affecting children in Zimbabwe. Multiple Indicator Cluster Survey report (2019) indicates that children stunting affects 23.5% of the children in Zimbabwe yet it is one of the markers of human capital development. Child undernutrition is also a public health concern in Mwenezi district as stunting affects 25.8% of the children (ZNNS,2018). The United Nations Children' Fund (2015) explains that stunting which occurs during the first 1000 days of a child's life poses highest negative long- term impact on education and earning potential person. The causes of child undernutrition are multi -faceted and therefor require a multisectoral approach. UNICEF (1990) categorise the cause of child undernutrition into immediate causes (inadequate dietary intake and disease), underlaying causes (household food insecurity, inadequate child caring practices and inadequate health services and sanitation) and basic causes. ZIMVAC report (2019) shows that 68.8% of households in Mwenezi district, are affected by food insecurity due to the occurrence of shocks and hazards such as droughts. Central to these is the persistent inability of households to provide adequate diets for all family members including children. Poor diets lacking key micronutrients contribute significantly to widespread morbidity and mortality in many children in Zimbabwe. ZNNS (2018) indicates that only 1.2% of children in Mwenezi receive minimum acceptable diet. The complementary feeding practices in Zimbabwe under child nutrition indicates that only 6% of children aged 6-23 months received the Minimum Acceptable Diet, although this was an increase from 2.1% recorded in 2020 (ZimVAC;2021). A minimum acceptable diet is an indicator which combines information on children who received the minimum dietary diversity and the minimum meal frequency. This is critical as it is essential to ensure appropriate growth and development for children aged 6-23 months.

Women and children are the major players in the supply chain, especially in the labor-intensive harvesting and processing of the mopane worms. Men act mainly as the intermediaries between the harvesters and markets (Ghazoul, 2006). The mopane worm trade takes place in several ways, through harvesters selling in bulk to other sellers, selling directly to consumers or engaging in bartering for food, clothing, or household supplies (Gondo, et al., 2010). In terms of monetary sale, Thomas (2013), reported a 50 kg maize meal sack of mopane worm grossing ZAR716,953 in Namibia in 2013. In South Africa the price of a 80 kg maize meal sack of mopane worms ranged between ZAR752,26 and ZAR1002,984 in 2005 (Makhado, et al., 2014). The cross-border trade between Botswana, South Africa and Zimbabwe is valued at

between ZAR422 million and ZAR638 million per year (Makhado, et al., 2014). The contribution of mopane sales to household livelihoods is difficult to assess without comprehensive data on the contribution (in cash or kind) of all livelihood activities. However, an indication of their contribution can be assessed by estimating the cash income derived from the sale of such products relative to other income sources. The widely observed phenomenon that income from forestry products tends to be of greater importance to poorer socio -economic groups is confirmed by survey data. In Mwenezi District for instance, mopane sales accounted for nearly forty percent of reported cash income for the bottom 25% of households, twenty percent of income for the middle 50% of households and less than 4% of cash income received by the top quartile (Dorward & Anderson,2002). The changes in Mopane worm availability have a snowball effect which has negative implications for Mopane worm's contributions to food security and livelihoods. Increasing in household vulnerability threat on food security, reduced income earning potential and malnutrition are among the potential consequences of sudden unavailability events.

1.3 Objectives of the study

1.3 Objectives

1.3.1 The main objective of the study was to evaluate the harvesting and marketing of Mopane worms and its' effect on household income and dietary diversity in Mwenezi District of Zimbabwe.

1.3.2 Specific objectives

1.To examine the harvesting of the Mopane worms in Mwenezi District of Zimbabwe

2.To analyse the marketing channels used by Mopane worm harvesting households in Mwenezi District

3.To determine the effect of Mopane worm harvesting on the income of households in Mwenezi District

4.To evaluate the effect of harvesting of Mopane worms to household dietary diversity in Mwenezi District of Zimbabwe

1.4 Justification

The study has been prompted by the idea of trying to investigate and find out the effectiveness, efficiency and impacts being derived from Mopane worms through evaluating the processes of harvesting and marketing and how they can be improved. The harvesting and trading of Mopane worms in Mwenezi district is a long-time subsistence and commercial non- timber activity which more information is needed to determine the extent of contribution of the Mopane worms to local household food security and dietary diversity as well as investigate the levels of incomes being derived from Mopane trading amongst the harvesters and the non-harvesters. The study seeks to give insights on areas of improvement from harvesting, marketing, household nutrition and income from Mopane worms in a sound economical and environmentally sustainable approach.

1.5 Scope/delimitations and limitations of study

The study concentrated in Mwenezi district, and some data was anticipated to be from across the district (marketing/trading) of MW while the 15 villages in ward 15 provided data about harvesting methods, household food dietary diversity status and household incomes. One major limitation of the study was funding mainly for travelling expenses during data collection and travel restrictions and gathering of people due to COVID 19 prompting the researcher to complement the face-to-face interviews with social media and telephonic interviews.

1.7 Outline of Thesis

The thesis is organised in five chapters. Chapter one gives the introduction and the background to the study, main objectives, specific objectives, justification of the study and delimitation. Chapter two focuses on the literature review of the study. Chapter 3 contains the research methodology, sampling, methods of data collection and ethical consideration put in place for the study. Chapter four outlines the results of the study with specific focus on the research objectives. Chapter five concludes the study with implications of the results, policy recommendations and areas of further studies.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In Zimbabwe, mopane woodland occurs in an arc of country, stretching from Tsholotsho in the northwest, through Plumtree, Mangwe, Matobo, Gwanda, and Beitbridge in the west and south, to Mwenezi, Chiredzi, and the lower Save Valley in the east. Within this area, mopane moths have two generations a year, in October-November and February-March, with the larvae often occurring in large numbers a month later. Mopane trees and the moths are also present in the Zambezi valley, but they are not as widespread there as in the southern Zimbabwe. Whereas harvesting of mopane worms was traditionally a subsistence livelihood activity, undertaken largely for nutritional purposes, increasing commercialisation of the resource has been taking place in recent years (Hobane, 1994, 1995; Rebe, 1999). Mopane worms are being increasingly widely traded throughout southern Africa, with evidence of marketing chains extending from southern Zimbabwe and eastern Botswana to South Africa, Zambia and the Democratic Republic of the Congo, as well as nationally within the main producing countries (Botswana, Namibia, South Africa and Zimbabwe). Despite this, there has been little research on the nature and dynamics of the marketing chains, markets or the traders involved.

For centuries, non-timber forest products have been key aspects of household diets throughout the world. In Southern Africa, mopane worms are widely harvested for household consumption and traded for income generation. The aim of this study is to identify and characterise the various supply and distribution chains for mopane worms, from harvest to consumption, and the nature of the markets and traders at work at different points along the chain particularly in Mwenezi District and Zimbabwe. Particular attention was paid to the methods used to harvest the mopane worms, the source areas, issues of the socio economic factors affecting the harvesting of mopane worms, gender relationships along the mopane worm value chain ,uses of mopane worms, different marketing methods being used in Mwenezi District and Zimbabwe at large, mopane worm contributions to general household food security and challenges affecting the contribution of mopane worm value chain and where possible, the kind and amount of value added to the product at points along the chain were also identified.

2.1 State of household food security in Mwenezi District

The Zimbabwe population continues to suffer from the effects of shocks and hazards resulting in increased food insecurity and malnutrition. According to Zimbabwe IPC Acute Food Insecurity Report (2020), about 2.61 million people in Zimbabwe are affected by high levels of acute food insecurity and this is main due to shocks and hazards experienced such as droughts, floods, high food prices, pests and diseases and reduced livelihoods as a result of covid 19 restrictions. ZIMVAC report (2019) shows that 68.8% of households in Mwenezi district are affected by food insecurity and furthermore, ZIMVAC (2021) show that 68% of households in Mwenezi district consume poor diets.

2.1.2 Measures of household food security

There are indicators which have been found to be cost effective, time sensitive and effective methods for analysing Nutritional Status (Jones *et al*. 2013; Webb *et al*. 2006; Headey & Ecker 2012). These include Household Food Insecurity Access Scale (HFIAS), The Household Food Insecurity Access Prevalence (HFIAP), Household dietary diversity (HDDS), Individual Dietary Diversity Score (IDDS) and Coping Strategy Index (CSI).

Household Food Insecurity Access Scale (HFIAS), which is an adaptation of the approach used to estimate the prevalence of food insecurity in the United States The method is based on the idea that the experience of food insecurity (access) causes predictable reactions and responses that can be captured and quantified through a survey and summarized in a scale identified a set of questions have been used in several countries and appear to distinguish the food secure from the insecure households across different cultural contexts (Coates *et al*., 2007). These questions represent apparently universal domains of the household food insecurity (access) experience and can be used to assign households and populations along a continuum of severity, from food secure to severely food insecure. HFIAS can be used to assess the prevalence of household food insecurity (access) (e.g., for geographic targeting) and to detect changes in the household food insecurity (access) situation of a population over time (e.g., for monitoring and evaluation). The frequency-of-occurrence questions were coded as 0 for all cases where the answer to the corresponding occurrence. The maximum score for a household is 27. Household response to all nine frequency-of-occurrence questions, coded with response code of 3. The minimum score is 0. The higher the score, the more food insecurity (access) the household experienced. The lower the score, the less food insecurity (access) a household experienced.

The Household Food Insecurity Access Prevalence (HFIAP) indicator, which categorizes households into four levels of household food insecurity (access): food secure and mild, moderately, and severely food insecure. The Household Food Insecurity Access Prevalence (HFIAP) Status indicator can be used to report household food insecurity (access) prevalence and make geographic targeting decisions. The Households are categorized as increasingly food insecure as they respond affirmatively to more severe conditions and/or experience those conditions more frequently. For instance, a food secure household experiences none of the food insecurity (access) conditions, or just experiences worry, but rarely. A mildly food insecure (access) household worries about not having enough food sometimes or often, and/or is unable to eat preferred foods, and/or eats a more monotonous diet than desired and/or some foods considered undesirable. A moderately food insecure household sacrifices quality more frequently, by eating a monotonous diet or undesirable foods sometimes or often, and/or has started to cut back on quantity by reducing the amount of food. A severely food insecure household has graduated to cutting back on meal size or number of meals often. Musemwa *et al*., 2015 used the HFIAS and HFIAP methods in a study conducted in South Africa assessing household food insecurity in the poorest province of South Africa. It is a reliable method as they discovered that it can be able to derive factors that affect food access and its severity cause of food insecurity.

Individual Dietary Diversity Score (IDDS) is an indicator that assesses the number of (pre-determined) food groups which were eaten by a specific target group the previous day or night. It is an indicator of a diet's micronutrient adequacy, an important dimension of its quality. It does not measure the intake of kilocalories. Individual dietary diversity score (IDDS) is used as a proxy measure of the nutritional quality of an individual's diet. HDDS is used as a proxy measure of the socio-economic level of the household and is based on the same 12 food groups. An increase in the average number of different food groups consumed provides a quantifiable measure of improved household food access. In general, any increase in household dietary diversity reflects an improvement in the household's diet (Ruel, 2002).

Another method is that of the Coping Strategy Index (CSI) an indicator of household food security. it makes use of the way in which households cope with acute food shortages and during food insecure periods. Maxwell *et al.,* (2003), suggested the Coping Strategy Index includes four categories: dietary changes (eating less preferred food); short-term measures to increase household food availability (borrowing, gifts, consuming seed stock); short-term

measures to decrease number of people to feed (short-term migration) and rationing, or managing the shortfall (mothers prioritizing children/men, limiting portion size, skipping meals, skipping eating for whole days etc. According to Collins (2004), the CSI method was employed by WFP to monitor changes in the food security status of refugee populations from the Democratic Republic of Congo, Burundi and in Western Tanzania in response to shocks such as market closures, movement restrictions, and reductions in relation to size.

2.2 Harvesting of mopane worms in Mwenezi District

Women and children are usually involved in MW collection but in recent years men and youth have participated in the gathering of this product, attracted by the income earning opportunities from the supply and trading of MWs. Peaks in abundance of this species are between November and January (major) and March –May (minor), though population numbers and location of outbreaks vary from year to year. The harvesters use several ways to collect the MW, including climbing the mopane trees and peak, shaking of the mopane trees and peak the fallen MW, cutting down the trees and peak the MW and waiting for the MW to climb down the trees and pick. However, the last method mentioned requires that the MW grows big enough to reach maturity and climb down of which, due to high harvesting demand, this stage is rarely arrived at. Outbreaks of MW although seasonal, are very timely in that they occur during the early months of the rainy season, when most rural households need cash for food and school fees. However, the high inter annual variability in production means that these products are not an exceptionally reliable income source (Mopane Worm Market Survey: Southern Zimbabwe,2002)

2.2.1 Source areas of mopane worms in Zimbabwe

Mopane worm outbreaks occur in a number of districts in Zimbabwe and importantly, the worms occur in areas where mopane trees are abundant. Some of the major source areas are Gwanda, Beitbridge, Bulilima, Bubi, Mwenezi, Chikombedzi, Chiredzi, Mangwe, Matobo and Plumtree (Mopane Worm Market Survey,2002).

2.2.2 Socio economic factors affecting mopane worm harvesting.

Some of the factors include age of harvesters, gender of the harvester of which mostly women and girls are involved, educational level contributes, as the comparatively learned ones are less likely to participate in the harvesting of mopane worms due to supposedly low -income levels

from mopane worms, where many possible harvesters avoiding the activity (Frost,2002). The social capital in relation to group affiliation, household size also determines the extend and level of involvement in the activity of harvesting, lack of institutional laws to protect and govern the harvesting of mopane worms in ensuring continuality and sustainability thus improving regulation of the natural resource, distance to the nearest harvesting sites affect harvesting as transport costs can be unbearable, or the young and elderly cannot endure the distances walking to harvests woodland. Lack of policy framework that deals with harvesting of mopane worms makes is a haphazard activity that may lack sustainability approaches to harvesting of this natural resource (Hobane,2001)

2.2.3 Gender relationships in mopane worm value chain

During mopane worm seasons which occurs during months of December/January and April/May (Mpuchane et al. 2000), women who constitutes 96% of harvesters (Stack et al. 2003) and children (an economically vulnerable group) are mostly engaged in harvesting and selling MWs. The harvesting and processing of mopane worms have traditionally been activities carried out by women and children (Hobane, 1994). This still applies largely in more remote areas, though closer to the main urban centers, young unemployed men may also be involved in collecting, often under contract to a local trader. Men also generally dominate the more lucrative long-distance and large-volume trading chains in mopane worms. Women are confined largely to collecting and processing mopane worms, and to selling small volumes at open markets and sales points along the roadside or at bus termini and municipal markets (Frost,2002) Most women collectors and processors come from rural communities and are traditionally highly immobile. They also have many domestic social obligations to fulfil – working in the fields, harvesting food, cooking, looking after the children, collecting firewood and water. In addition, it is more difficult for women to find secure but inexpensive accommodation in towns (Mopane Worm Market Survey,2002).

2.3 Uses of mopane worms.

There is a continuing interest in MW as a food resource for human (Motshegwe et al. 1998; Illgner & Nel 2000; Mpuchane et al. 2000; Ghazoul 2006) or as a feed resource for livestock (Madibela et al. 2007) and as well as its biology (Frears et al. 1997; Frears et al. 1999). MW is an important natural resource for many people in Southern Africa and it is a source of protein and cash, especially among the poor, hunger-averse rural dwellers. Supplementing seasonal shortages in cash or food (the mopane worm outbreaks in December/January occur at a time when rural families are short of both food and cash); buffering families against unexpected shortages in food or income caused by drought, illness, or some other sudden events; Supplementing expenditure on important things, like education, food, health, clothing, household utensils, agricultural tools, improved shelter, travel, and social functions; and Providing cash for investment in various productive enterprises, such as buying additional MW stocks or other stocks or other commodities for trading, purchasing agricultural inputs (including livestock), engaging in non-farm enterprises, or building household assets generally so as to improve the family's capacity to expand future agricultural production or other business activities.

2.3.1 Human consumption

Mopane worms are rich in protein and other minerals. Illgner & Nel (2000) indicated that Africa as a whole has the lowest protein intake per capita per day, and given the severe financial constraints on the continent, especially in rural areas, the availability of alternative sources of protein is critical. The significance of mopane worms to rural people's livelihoods is that they have three times the protein content of beef by unit weight and can be stored for many months once dried (Potgieter et al., 2012). Various studies show that mopane worms contain 48% to 65% protein, energy at a concentration of 444 K.cal/100g to 543 K.cal/100g, minerals ranging from 4 g/100g to 11 g/100g, carbohydrates ranging from 11 g/100g to 14 g/100g, and a fat content of 16% to 18%. Therefore, 100 g of dried mopane worms provides up to 76% of a human's daily protein requirement as well as many of the required vitamins and minerals such as phosphorus, iron and calcium (Bartlett, 1996; Potgieter et al., 2012). Thus, mopane worms are consumed by humans and provide improved nutritional values and promotes dietary diversity among household (Frost,2002).

2.3.2 Livestock feed

The use of insects for waste conversion into animal feed and fertilizer requires judicious choice of substrate in view of concerns regarding contaminant loads and pathogens occurrence. (Keleme, Nias &Torts,2015). Hence, with more research and innovation approaches, mopane worm wastes can be converted to animal feed and can be a relatively cheaper source of feed as it occurs free of production cost compared to fish meal which requires intensive production costs. Insects can be used as a replacement for fish meal and fish oil in animal diets. Global industrial feed production in 2011 was estimated at 870 million tons, worth approximately US$350billion (IFIF,2012). Meal and oil from both fish and soybean are used for compound aquafeed and animal feed. Fish meal and fish oil were derived from 20.8 million tons (19%) of the global fish production of 145 million tons in 2008. This concerned mainly small, pelagic forage fish. The worldwide production of fish meal and fish oil in 2006 was 5.46 and 0.95 million tons, respectively [processing yields of 22.5% and 5%, of which 68% and 89% were used in aquaculture, respectively]. Aquaculture has grown from providing 4% of global fish supplies by weight in 1970 to 38% in 2008, and production is estimated to grow at more than 8% a year. Not only this growth but also marine overexploitation, from 10% of stocks in 1974 to 32% in 2008, increases the costs of producing fish oil and fish meal. Prices of soybean and soy oil have also increased due to a rapid expansion in demand (particularly in China) caused by a growing world population, whereas growth in production has slowed. With world prices of feed ingredients increasing, the industry is looking for alternative protein sources. There is much interest in possible replacements for these expensive ingredients. The most promising insect species for industrial production are BSF, the common house fly, the yellow mealworm, the lesser mealworm, silkworm (*Bombyx mori*), and several grasshopper species, BSF larvae convert manure to body mass containing 42% protein and 35% fat, which makes them a suitable source of feed for both livestock and fish (Kozanayi,2002).

2.3.3 Other uses

Barter for basic consumption goods (grains) and small household goods (kitchen utensils) and clothing. Although in tropical countries the retail price of edible insects is often higher than that of conventional meat, insects are regularly preferred, indicating how much they are appreciated as a delicacy. For example, the availability of the mopane caterpillar on the market affected the sale of beef, which was cheaper, among the Pedi in South Africa (Adalla, 2010).

2.4 Marketing of mopane worms

Several people are involved in the marketing of mopane worms. Women are the main sellers of mopane worms in town and at small business centers (rural growth points). They mostly sell mopane worms in small volumes whereas men tend to dominate the large-volume trade. Generally, however, the participation of young men was low in almost all areas except in Beit Bridge (Mopane Worm Market Survey; Southern Zimbabwe, 2002).

Mopane worm harvesters presently trade over 80% of their yield, whereas it was once common for harvesters to collect mopane worms for home use and reciprocal bartering only (Stack et al. 2003, Gondo et al. 2010). In Botswana alone, the industry employs an estimated 10,000 people annually (Shackleton & Gumbo, 2010). Households attach importance to income from the mopane worm trade because the harvest occurs during the 'lean season'- between agricultural harvests and just before the school year begins, when demand for cash to pay for school fees and uniforms is high (Stack et al. 2003). The regional trade of mopane worms has also flourished, with the cross-border trade between Botswana, South Africa and Zimbabwe valued between ZAR422 million and ZAR638 million per year (Makhado et al. 2014). Ngundu is situated about 95 km south of Masvingo on the road to Beitbridge. Romwe is a small rural community located about 8 km north-west of Ngundu. People from Ngundu and Romwe have traditionally harvested mopane worms mostly from commercial farms around Rutenga-Mwenezi and Chiredzi-Triangle, either for their own consumption or for selling at Ngundu. These areas are preferred because they are closer to Ngundu (about 70 and 110km respectively) than either Beitbridge (almost 200km), or Chikombedzi (about 160 km on a mostly dusty and pot-holed gravel road). proximity means that mopane-worm collectors and traders can travel to them to buy or collect worms and return home the same day. The people do not have to consider the availability and cost of accommodation, something that must be considered by traders travelling to more distant places such as Beitbridge and Gwanda. Nevertheless, those wishing to trade in large volumes of mopane worms go to Beitbridge, Gwanda or Chikombedzi (Mopane Worm Market Survey,2002).

2.4.1 Farm gate

This channel involves of individuals buying Mopane worms for different reasons which include resale, buying for social functions such as funerals, customary celebrations, weddings, religious celebrations, and home use. It is a less popular shortest and simplest marketing channel and subsistence in nature (Mendoza, 2013). The farm gate prices are low when compared to other prices of other marketing channels (Svubure, 2015). However, this mode of marketing has limited costs since there are no transport and limited packaging cost (Mendoza, 2013). Local marketing channels are generally flexible to the extent that even small produce that may not be accepted by formal markets, are exchanged. Being the cheapest and simplest form of market outlet, the channel has the advantage that sellers determine the price for their Mopane worm which at times cannot be negotiable. Middlemen and their fees are eliminated, though demand is low, seasonal and often involves low quality Mopane worms. When the quantities involved are relatively small, there is little competition among collectors, MW stocks kept at home and prospective buyers to travel through the communal areas to buy from collectors. Displaying mopane worms along a main road can serve to advertise the wider availability of mopane worms in neighboring communities (Frost,2012).

2.4.2 Roadside

This is a marketing channel which involves displaying goods along the road street or outside the gate of schools, companies, office. Some of the advantages associated with this channel are low price of mopane worms hence consumer can easily buy due to low prices, and accessibility to travellers is easy thus quantities of mopane worms sold can be huge, also it requires small amount of capital (Mopane Worm Market Survey, 2002). However, this channel poses disadvantages like quantities of mopane worms being limited since mostly the operation is in small scale. Again, the mopane worms can be wasted (Frost, 2002). Mopane worms are also sold along the main roads in rural areas, usually close to source. Bags of collected mopane worms are stacked by the roadside, awaiting sale and transportation to the main cities (Mopane Worm Market, 2002).

2.4.3 Speculators

Speculators are important to market because they bring liquidity and assume market risk. They are the primary participants in the futures market. For mopane worm trading, speculators travel into the mopane worm producing areas and buy at low prices and then sell in lucrative markets for higher prices and make huge profits. The collectors usually sell to merchants in bulk. The merchants in turn transport the mopane worms to the towns and then sell them on to other traders (Mopane Worm Market Survey, 2002)

2.4.4 Local markets

Local markets as a trading channel have advantages including low overhead expenses but have a disadvantage of relying on word of mouth or drive-by. Women and men selling at open-air markets at bus termini in Beitbridge, Bulawayo, Masvingo and Rutenga. Women selling mopane worms on the street or on the verandas of large city-center shops such as OK Bazaars. Women in beer halls selling mopane worms as a snack (e.g. Ritz night club in Masvingo and women at Ngundu and Chitubu beer halls) (Mopane Worm Market Survey,2002).

2.4.5 Major agricultural markets in Zimbabwe

This channel consists of bulk distribution (buying and selling) of Mopane worms. Wholesalers purchase Mopane worms directly from the harvesters or through commission agents. Wholesalers are essentially involved in speculative and arbitrage behavior taking advantage of gluts and scarcities on the market, especially the international market due to differences in seasonal production, supplying produce to Europe for example during the winter season (Svubure, 2015). Large buyers ("*matraders*") representing wholesale food packaging companies such as Jaggers, Jasbro, Neshuro, Quality Foods. Supermarkets and shops in the towns and cities, particularly in high-density areas, selling pre-packed and labelled mopane worms bought from the wholesale food packing companies (Mopane Worm Market Survey, 2002).

2.4.6 Retailers

Retailing refers to the sale of produce to the consumer, usually in small quantities. Wholesalers and retailers play an increasingly important role in setting production, packing and distribution standards (KTA, 2018). The last line in the marketing chain is of retailers, both large and small-scale. Instead of buying from various wholesalers and/or producers, large-scale retailers tend to set up contracts with specific wholesalers, as they need to monitor the flow and uniformity of their supplies quite closely. Small and individually owned supermarkets usually source supplies from smallholder farmers or they purchase produce on the open markets such as Mbare Musika in Zimbabwe (KTA, 2018). Supermarkets are the main retail outlets for pre-packed and labelled mopane worms supplied by wholesale food packing companies such as Quality Foods, Jasbro and Savonuts. Supermarkets and shops in the towns and cities, particularly in high-density areas, selling pre-packed and labelled mopane worms bought from the wholesale food packing companies. Shop owners who sell in sealed packets (sometimes packed by the seller), or who use cups to measure out standard amounts from open sacks (Mopane Worm Market, 2002)

2.4.7 Processors

They are registered and they add value to Mopane worms through drying, roasting, salting, spicing, boiling, and packaging. This needs high capital, energy and packaging costs and yet the products produced are marketable worldwide (Lohano, 2012). In Zimbabwe these processing companies include big supermarkets like OK Zimbabwe, Pick &Pay and other small shops like Mutema, among others. These processors either buy directly from the harvesters or from the wholesalers but they require high quality Mopane worms Processors require varieties with high dry matter content and low sugar levels which differs from retailers who require any variety (Mopane Worm Market Survey, 2002). This is the most difficult and labor- intensive part of processing, particularly if the larvae are collected before they are ready to pupate. When fully grown, larvae have relatively empty guts. Instead, their bodies are filled with yellow nutritive material that is preferred by consumers. Buyers indicated that, if not properly squeezed, mopane worms are long and turgid. Thus, when they buy the worms from suppliers the first indicator, they use to assess the quality of the worms is size. To confirm if the worms' guts are clean or not, they randomly take samples and break the worms in half and look at the gut (Frost,2002)

Two basic methods are used to squeeze out the frass from the guts of the larvae. The conventional way is to process the larvae individually by squeezing them between the thumb and forefinger. Whereas the pressure can be adjusted depending on the size of the larvae and the amount of undigested material in its gut, the spines on the larvae puncture the hands of the workers, causing bleeding and sores. The hands also get discolored by the body fluids of the larvae. To prevent excessive damage to their hands, some collectors tie bark fibers around their fingers. Those who can afford to, buy gloves which are more effective than fiber. Processing the larvae is often done at night. Alternatively, to reduce damage to fingers, some processors use a bottle as a roller to expel the frass (Kazanayi & Frost,2002). Though quick, as more than one worm can be processed at a time, the bottle is too hard and squeezes almost everything from the gut, including the desired yellow material.

The utility of a product such as mopane worm is a function of its form, location, concentration, and time of availability. Changes in these attributes along the marketing chains adds value to the product as it moves from producers (collectors) to consumers. Mopane worms are an irregularly occurring, dispersed resource. Initial value is added through collection and processing of mopane worms, which changes both the form and the concentration of the product. Batches of processed and dried mopane worms, situated in the collection areas, are then moved to consumer markets, either directly by the collectors themselves or through intermediate traders who then sell on to the wholesale markets. This adds further value as the product is relocated to the consumer markets (Kazanayi et al,2002). Of course, some consumers can also collect mopane worms themselves, directly from the production areas, thereby deriving sole benefit from the utility of the product. Wholesalers may repackage their stocks into smaller, sealed, and labelled packs, for sale in formal outlets (shops, supermarkets), or sell in bulk direct to retailers in open markets. Retailers, whether trading with consumers through shops or formal or informal markets, can also obtain stocks direct from intermediate traders. Small traders in bars, restaurants or open-air markets may add further value by cooking mopane worms and adding spices before selling them on to consumers (Kazanayi & Frost,2002)

2.5 Constrains on mopane worm marketing.

At local level, in Zimbabwe, prices in most areas and cases are determined by the buyers rather than the sellers. Collectors complain that, in most cases, the buyers cheat them, especially if the transaction involves barter trading. Some suppliers reported that they live far away and have brought their mopane stocks to Beitbridge by donkey cart. Suppliers are therefore under pressure to sell because it is not worthwhile taking their mopane worm stocks back home. Moreover, accommodation at Beitbridge is expensive, so most suppliers try to sell their stocks and return home the same day (Mopane Worm Markets Survey,2002). Under such circumstances, buyers have an advantage and can negotiate prices downwards. Thus, high, and unsustainable transport costs become one major challenge associated with the marketing of mopane worms. The source areas for mopane worms are often far from the main markets, most of which are in urban areas. Traders either way often must travel long distances to do business. With the recent increases in the price of fuel bus fares have surged, greatly increasing the cost of travel. This has inhibited many people from travelling long distances to collect or trade in mopane worms (Mopane Worm Markets Survey,2002). In many cases, traders are resorting to hitch-hiking on haulage trucks, the drivers of which charge a relatively low fee for transport. Unlike buses, where the fares are fixed, a passenger can negotiate with the haulage-truck driver over the fee. Moreover, truck drivers do not always charge an additional fee for ferrying goods or, if they do, it is usually less than on public transport.

Goods such as toiletries, kitchen utensils, mealie meal, and second- hand clothes can also be bartered form MW, particularly in the more remote areas where people are short of food and basic household necessities. Some buyers said that, where there is extreme poverty, anyone who brings food or clothes to barter will be able to obtain a lot of mopane worms (Mopane Worm Markets Survey,2002). Being a barter trade, the rate of exchange fluctuates considerably, depending on the imported items being offered and on people's needs. The emergency of COVID-19 has also worsened the marketing of mopane worms as travelling restrictions meant that collectors could not travel to lucrative urban markets. Cleaning the mopane worms is labor intensive, time-consuming, and damages and discolors the processors' hands.

Collectors face several natural hazards, including the risk of being bitten by snakes. The source areas of mopane worms are often remote and relatively inaccessible. This adds considerable costs in terms of time and money in transporting mopane worms to the major markets. Some

of the commercial farms where the traders used to collect mopane worms have either been invaded or been taken over by government for resettlement. The newly settled farmers are no longer allowing traders to collect mopane worms from these farms. In both December/January and March/April, if it rains incessantly, it is difficult to dry mopane worms properly. As a result, they become rancid or moldy and are then rejected by prospective buyers (Mopane Worm Markets Survey,2002)

For traders from rural areas, the high cost of accommodation in market towns such as Beitbridge means that they are under pressure to sell their stocks quickly and attempt to return home on the same day. This often results in them accepting lower prices, as they do not have the time to engage in protracted negotiations. For others, especially cross-border traders, the lack of decent and affordable accommodation means that they often end up sleeping in the open at the border posts because they cannot get or afford to rent accommodation. This is a major problem when it rains, not only because of personal discomfort but also because their stocks may get wet and spoil (Frost, 2002).

2.6 Contributions of mopane worms to household food security

A significant number of poor people around the world who live in, or nearby forests and woodlands depend on these ecosystems for their livelihoods, welfare, and income generation (Quang & Anh,2006). In Zimbabwe, this dependence was found to be much more widespread among poor people and it fulfils important household needs (Kozanayi & Frost, 2002; Phiri, *et al*., 2004). Non-timber forest products support human wellbeing and livelihoods through direct household consumption, income generation, or provision of safety nets in cases of unexpected events; play important roles in local cultures and spirituality; and provide cash savings for households and governments (Shackleton & Pandey, 2014).

Although NTFPs are known to have important socioeconomic value to rural households, there is still a lag in recognizing their contribution to local and national economies especially in developing countries, where the dependency is high. (Shackleton, *et al*., 2001). As a coping strategy during times of unfavorable events, rural poor household soften find themselves having to utilize more NTFPs as safety net to meet their household needs than under normal circumstances (Shackleton, *et al*., 2001). It is during difficult times such as the loss of income by the breadwinner or the occurrence of extreme weather events such as floods and droughts

leading to loss of crops and livestock, that the emergency use of NTFPs is more evident (Shackleton& Shackleton, 2004; Paumgarten, 2005; Shackleton, *et al*., 2007; Shackleton & Pandey, 2014). Importantly, NTFPs provide a buffer to prevent households from plunging further into abject poverty (Shackleton & Shackleton, 2004; McSweeny, 2005). With changing climate, the frequency with which extreme weather events occur is increasing and this is known to impact significantly on poor people, mainly in developing countries, who are dependent on subsistence crop production and animal husbandry (Morton, 2007).

Besides being a primary source of income for poor households, NTFPs have also been used as a means for cash-saving. By harvesting and utilizing the resources freely available in the forests and woodlands at relatively negligible or no cost, poor households can afford to save their scarce finances or use it to cover other household costs and livelihood necessities (Shackleton, *et al*., 2007). In households where the income generated by the breadwinner cannot provide for the entire family's living costs, NTFPs play a crucial supplementary role by providing food, energy, shelter, and medicine, thus saving money for the families which can then be spent on other cash-intensive household needs and education (Shackleton, *et al*., 2007). Moreover, through provision of cash saving means to households, NTFPs help to lessen the extent and impact of poverty on poor households and therefore reduce the burden on the state. Therefore, by securing the availability and sustainable use of NTFPs, including MW governments can take advantage of this relatively freely available cash saving mechanism and alleviate the burden of poverty on state coffers. This, however, should not be used to diminish the need to provide essential services to poor rural communities (Shackleton, *et al*.,2007; Shackleton & Pandey, 2014).

2.6.1 Direct contribution of mopane worms to household food security

Mopane worms are popular and profitable edible insects that are consumed for their nutritional value and traded to generate income (Voorthuizen, 1976; Styles, 1995). Their seasonal availability creates both short-term (a few days) and medium-term (a few months) employment opportunities for many unemployed people. It has been estimated that the trade in mopane worms has the potential to create over 10 000 seasonal jobs across southern Africa (Styles, 1995), but the reduction in the numbers of mopane worms can impact negatively on that potential. Besides being a primary source of income for poor households, NTFPs have also been used as a means for cash-saving. By harvesting and utilizing the resources freely available

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In households where the income generated by the breadwinner cannot provide for the entire family's living costs, NTFPs play a crucial supplementary role by providing food, energy, shelter, and medicine, thus saving money for the families which can then be spent on other cash-intensive household needs and education (Shackleton, *et al*., 2007). Moreover, through provision of cash saving means to households, NTFPs help to lessen the extent and impact of poverty on poor households and therefore reduce the burden on the state. When mopane occur in large numbers, they are collected by people, cleaned, dried, or roasted, and either kept for consumption, or more commonly nowadays, sold or bartered. Data collected from southern Zimbabwe show that most households harvest mopane worms when outbreaks occur and that 79-95% of these households will then sell at least some of what they have collected or exchange them for other goods. Money obtained from the sale of mopane worms is important both to rural producers, who harvest the caterpillars in the wild, and to urban traders, who buy mopane worms from rural producers or other traders and sell them eventually to consumers.

2.6.1 Indirect contribution of mopane worm to household food security

The harvesting and trade of NTFPs serves as an important economic activity for people in rural areas where there are limited prospects of formal employment opportunities (Vedeld, *et al*., 2007). The contribution of NTFPs to household income can be incredibly significant, it has been found to account for up to 90% of the household income (Shackleton, *et al*., 2008). This is a particularly important contribution of NTFPs to reducing poverty and household vulnerability. The use of NTFPs to generate income may happen in two ways. Firstly, as the primary source of income wherein NTFPs are harvested and traded as fulltime employment. This can provide a pathway out of poverty where economically valuable products are a major part of the traded resources (Shackleton, *et al*., 2008). Intensification and specialization could be used as the means to maximize income from NTFP trading to enable the traders to venture into other capital-intensive income generating activities or to turn the trading into a valuable business. However, harvesting should be done sustainably to avoid undermining the resource base upon which livelihoods are based (Shackleton, *et al*., 2007; Vedeld, *et al*, 2007). Secondly, in instances where primary income generation is through formal employment, NTFP

harvesting, and trading would be done as a secondary source of income (Illgner &Nel, 2000). This happens predominantly where the availability of the NTFPs may be seasonal or dependent on climatic conditions (Greyling & Potgieter, 2007; Thomas, 2013).

2.7 Challenges affecting the contribution of mopane worms to household food security.

The availability of the worm relies on the amount and timing of rainfall (which in most seasons is unreliable and erratic) and hence the vegetative production of mopane trees, relative to the hatching of its eggs from the emperor moth (Madibela et al.2007). Mopane worm also faces a threat of being over exploited by harvesters because of lack of regulatory and monitoring policy (Arntzen & Fidzani,1998). These threats further strengthen a case for research into finding existence of any difference in mopane worm population with a view of using genetic biology and breeding to enhance its productivity. The increased commercialization of the mopane worm trade in Southern Africa has led to over harvesting with collectors now collecting substantially more than a single person would have traditionally harvested for a family (Rebe, 1999). In South Africa, alone, overharvesting has led to a strong demand for imported mopane worms from Botswana (Moruakgomo, 1996; Letsie, 1996). In addition to this challenge, there is also a severe lack in basic knowledge needed to manage the resource. Current initiatives to expand these returns have largely remained biased towards seeking technical and institutional innovations in the management and utilization of such forest resources. Empirical data from other studies (Campbell, Luckert., Mandondo., Matose., & Nemarundwe.,2001; Campbell., Luckert., Mandondo., Matose., & Nemarundwe., 2002), show that natural resource management in semi-arid landscapes of southern Zimbabwe is primarily about local people, the users of resources themselves, far more than it is about prescriptive technical interventions from outside. Resource management interventions, therefore, need to be grounded on people's own knowledge systems, social and production objectives, and constraints (He, Zhou, Weyerhaeuser, & Xu, 2009; Pei, Zhang & Huai, 2009).

Exclusionary approaches to the management of NTFPs often resulted in conflicts and unsuccessful conservation of resources as local people continued to access them illegally (Pimbert & Pretty, 1995). In the last two decades, however, forest management approaches in developing countries have been characterized by a desire to combine both conservation and improvement of well-being of the communities living at the forest margins. In these new approaches, the participation of local communities in the management process is seen as crucial

for striking a balance between conservation and improvements in human lives and key for sustainable management of resources (Wilshusen., Brechin., Fortwangler &West, 2002; Borinni &Feyeraband, 1996). Ironically, many such new initiatives have not yet resulted in sustainable utilization of NTFPs and neither have they resulted in the improvement of the lives of the forest dependent people (Newmark & Hough, 2000; Marshall, Newton & Schreckenberg, 2003; Belcher & Schreckenberg, 2007; Newton, 2008; Strandby, Prado, Nielsen, Smith, Marten & Kollman., 2008; Jensen & Meilby, 2008; Gubbi & Macmillan, 2008). This has fueled debates on the utility of greater local involvement in management between conservationists and proponents of people-centered approaches. The former is calling for 'stricter enforcement protection' while the later consider this proposal as a 're-invention of the square wheel' and call for alternative people-centered approaches to be sought (Wilshusen *et al*., 2002, Borinni &Feyeraband, 1996).

2.8 Conceptual framework

Mopane worm consumption is conceptualized to contribute to households' food security directly or indirectly through availability. access and utilisation. The inclusion of mopane worms in households' diet therefore has a potential of improving the dietary diversity of the household, which is a direct contribution to food security that enhances household food availability. Availability of mopane worm could also improve food utilisation. Mopane worm has three times the protein content of beef by unit weight-a 100g of dried mopane worms provides up to 76% of human daily protein requirement as well as other required micronutrients such as phosphorous, iron and calcium (Potgieter *et al.,* 2012). Furthermore, income earned from mopane worm commercialisation or barter can be used to purchase or secure other food items needed by a household (Mpuchane *et al.* 2000). This serves as an indirect contribution of mopane worms to food security, which enhances food access and availability as well as utilization.

2.9 Conclusion

Food insecurity, which has potentially long-term consequences on health and child development is a significant issue which needs to be addressed. Harvesting methods of mopane worms should provide for the present and sustainably cater for the future generations and at the same time improving the marketing channels of Mopane worms for the overall benefit of all involved in the value chain. There is evidence that mopane worm harvesting for

consumption and trade, presents an important livelihood for rural people however environmental change in the rural areas may pose a threat to the sustainability of this livelihood activity. Poor regulation and management of mopane worm resources create an enabling environment for unsustainable resource exploitation. Investigations on the effects of environmental, cultural, and socioeconomic change on mopane worm are thus important for livelihood and resource sustainability.

CHAPTER 3
METHODOLOGY

3.1 Introduction

. This chapter outlines methods and procedures that were used to achieve the stated objectives. It presents the types and sources of data and the analytical methods that were used. The first section describes the study area followed by the data collection section, sampling and the model used in data analysis. The last section covers other tools used for data analysis. Descriptive and T/ test statistics were used to analyse the data.

3.2 Description of study site

The study was carried out in Mwenezi district, which is a small district situated in Southern part of Zimbabwe. It is bisected by Mwenezi River and the A4 highway, the main thoroughfare that connects the town of Beitbridge on the border with South Africa to Masvingo town. Mwenezi district lies in natural region four and five and the district is prone to droughts and experiences low mean annual rainfall regions of about 450mm. The district has a human population of 166 993 disaggregated as 79 738 males and 87 255 females. The small amounts of rainfall received in Mwenezi district have created a desire amongst households to shift more towards livestock farming, especially cattle and goat, ranching, sugar cane plantations at Mwenezana Estates, crocodile farming as well as small/traditional grains in communal areas. The district had several irrigation schemes though some are non- functional. A number of rivers including Mwenezi River and Lundi provide gold panning and capture fisheries opportunities. Nonetheless, this is an area of chronic poverty and food insecurity. Due to its proximity to South Africa, cross border trade has become one of the most common livelihoods means.

The research was conducted in ward 15, which is 125km Southeast of Rutenga Business Centre with human population of 18 725 disaggregated as 8 426 males and 10 299 females. The ward is rich in MW and the enumeration area was done in the following villages: Ndavana, Mafungata, Kovogo, Makovere, Masaga, Maphlopani, Mahosi 2, Chauke, Mapimele, Mahosi 1, Dhumani, Livombo, Mukwazukwazu, Makanani and Hanyani. Mopane worm methods of harvesting and quantities harvested per season per household, MW marketing channels and its effects on household food dietary diversity and income data was collected in 15 villages of ward 15.

3.3 Research design

Mixed method approach was adopted for the study, and this encompassed qualitative and quantitative research methods and structured questionnaires as the main tool of data collection, key informant interviews and observations. Data collection was conducted following Covid-19 regulations which include social distancing, proper wearing of masks and regulation sanitisation. The researcher provided the interviewees with masks and sanitizers. The research is descriptive in nature.

3.4 Sampling procedure

The snowball sampling (Goodman,1961) technique was used to sample the respondents. The technique was used to purposefully target the community of harvesters and non- harvesters including traders for their expertise and knowledge on MW in ward 15 of Mwenezi district. The respondent driven (Heckathorn,1997) purposive non-random sampling technique entails identification of respondents through recommendation from other respondents who are knowledgeable on the subject (Kim., et al ,2012; Cox, 2015). In using this sampling method, initial observations were made to guide the sampling of the subsequent observations through referral. This method is regarded as the most feasible and reliable in studies where access to remote respondents depends heavily on social networks, trust, and human reputation (Cox,2015). Moreover, the exploratory nature of snowball sampling enables the researcher to find subsequent study sites which would otherwise be unknown to the researcher. Nonetheless, this technique has an inherent problem of lack of generalisability and introduction of bias. Snowball samples are often, strongly biased towards individuals with relationships in the population. These raise the question of whether the results can be extrapolated to the wider populations which shares the demographic characteristics or whether they are limited to a population that has undergone similar social experiences (Biernacki &Waldorf, 1981; Faugier & Sargeant, 1997). As a result, snowball sampling techniques does not permit the researcher to use probability statistical methods because the sample would not be randomly drawn and is highly dependent on the individual choices of the original selected respondents. This bias is inherently embedded in ethnographic methods which are used to recruit respondents in the initial stages of research in which widely known individuals are highly represented in the initial sample.

3.5 Data collection procedure

This study used qualitative and quantitative data collection and analysis techniques to investigate the contribution of MW to rural livelihoods through examining the harvesting methods used by MW harvesters, the MW marketing channels they use and the overall effects on household dietary diversity and income levels between harvesters and non- harvesters. Seventy semi-structured interviews were conducted in the 15 villages mentioned in the research site description. Semi-structured interviews were conducted with both harvesters and non-harvesters of mopane worms, altogether 50 harvesters and 50 non-harvesters were interviewed. The questionnaire was divided into two sections. The first section comprised both open-ended and closed questions aimed at building a socioeconomic profile of the respondents. The second section comprised open-ended questions to solicit information about the significance of mopane worms as a food source and trading commodity; the marketing channels used by harvesters and the effects associated by harvesting or non-harvesting in relation to household income levels at the end of a season and the dietary diversity scores. The interviews were conducted using Shona, Shangani and English, depending on the language preference of the respondent. Respondents were encouraged to use their mother tongue. This was aimed at ensuring that they were comfortable during the interview and thus could express themselves sufficiently without language hindrance.

3.6 Data analysis procedure

The following data analysis methods were employed, descriptive statistics, t test and one- way Anova. Data were analyzed using SPSS (Statistical Package for Social Sciences) version 16 and Microsoft Excel 2007. The advantage of SPSS is that it is a storage facility and consist of strong analytical tools that are easy to use. The cleaning process involved checking data inconsistency and quality of information such as data entry errors.

3.7 Ethical considerations

Informed consent was sort first before data collection and confidentiality adhered to. Beneficence principle was observed during data collection and interaction. Respect for anonymity and respect for privacy was equally followed during all the research processes.

Before the commencement of the interviews the respondents were informed of the objective of the study and their rights to anonymity and termination of the interview at any stage that they so wish without prejudice or penalty. It was also explained that no compensation in any form

should be expected from their participation in the study. The respondents were encouraged to answer the questions in their first language to ensure that they were comfortable during the interview. Feedback of this study will be provided to the communities involved.

CHAPTER 4
RESULTS

4.1 Introduction

Mopane worms have been known to be available within the southern African countries. There is no documented history of the mopane worm dish in Zimbabwe. However, a stone-age pit discovered at Pomongwe Cave in Zimbabwe showed a deposit of dried mopane worms that are believed to be almost 6,000 years old (Masau, 2018). According to Food and Agriculture Association (FAO, 2018) the mopane caterpillar is one of the best-known and most economically important forestry resource products of the mopane woodlands in southern Zimbabwe, Botswana, and northern South Africa. It has been estimated that annually 9.5 billion mopane larvae are harvested in Southern Africa's 20,000km2 of mopane forest worth US$85 million, of which approximately 40 per cent goes to producers who are primarily women from poorer, rural areas. The worms are harvested during the rainy season, after which they are cleaned, sun-dried for preservation, and made available for consumption throughout the year. On a good day, an individual can harvest two buckets (40-50 litters,) of mopane worms. The woodlands on which they harvest belong to some other individual hence, on the first day of arrival an individual has to pay a access fee of a 4 litter (about 1 gallon) bucket of mopane worms and is free to harvest until they decide to leave. The tasty worms can be eaten dry and crispy as a snack, or can be drenched in sauce, or added to porridge made from maize. Mopane worms can also be added to a stew, boiled to soften them up, or simply eaten raw and fresh off a tree. When they are fresh, they are less chewy and their distinctive and unique flavour is undiluted by other ingredients. Mopani worms are eaten in among others Botswana, Zimbabwe, Zambia, Namibia, and certain regions of South Africa.

The Forestry Commission estimates the business could be worth half a million dollars each season. Each season mopane harvesting households. After harvesting mopane worms each harvesting seasons, the worms are sun- dried on sacks spread on the ground surfaces. In areas like Ganda in Matabeleland Province, buckets and sacks are seen filled to the brim with the mopane worms for trading in cash and for barter exchange. Mopane worms are the currency being used to purchase the grocery items that the family might need. Temporary homes and shops are set up along the roadside during the harvest season. Here, outside of the town of Gwanda, some people stay for the entire season, spending their days gathering worms from the leaves of the mopane trees, and then preparing them for sale. The harvest and sale of mopane worms is a booming industry. There has been some concern by conservation authorities with

regards to overexploitation and unsustainable harvesting of the mopane worms. Harvesters contribute to environmental destruction by cutting down trees to get firewood. Fires are built, and the worms are dropped in the ashes of the fire to dry them out.

In this section, study findings on the harvesting and marketing of Mopane worms and its' effect on household food security and income levels in Mwenezi District of Zimbabwe. It further presents findings on marketing channels used by Mopane worm harvesting households as well as the effect to the household incomes within in the district. This chapter details finding on the effect of mopane worms to the food security statuses of the harvesting household.

4.2 Material and Methods

Semi structured questionnaires with open and closed questions were used to collect data, Data was collected from 50 harvesting and 50 non harvesting households. The research was carried out in ward 15, in 15 villages of Mwenezi district. For finer details refer to chapter 3.

4.2.1 Challenges encountered during data collect.

Due to COVID 19, the travel and gathering restrictions resulted in cancellation of Focus Group Discussions as a means of data collection. Again, due to budgetary constraints, the sample size was relatively small because of the limited time for field work caused due to curfews were imposed in Zimbabwe during the period of data collection. The study used the snowball sampling technique, as a result the researcher was only able to interview the respondents to whom were referred by fellow respondents.

4.3 Results

The section that follows presents the results of this research based on the stated main and specific objectives.

4.3.1 Harvesting of Mopane Worms

4.3.1.1 Persons responsible for Mopane Worms harvesting

Harvesting of mopane worms is practiced by both women and men within the Mwenezi communities, however women and girls dominated the activity by 56% of the interviewed respondents while men, constituted 10%. 33% of the family members are also involved in the harvesting of mopane worms as wee with the least being practiced by boys. Those who do harvesting of mopane worms usually go for weeks into the mopane forests for harvesting where they carry food stuffs to last them for the harvesting period. It was noted that the harvesting of mopane worms is a time- consuming and non- financially rewarding exercise that requires for people to be camped in the woodlands for some weeks hence the women generally have the patience to be involved in harvesting of mopane worms while the men are more interested in the marketing activities as these have an immediate financial reward attached to it.

4.3.1.2 Frequency of harvesting of Mopane Worms

The majority (75%) of respondents carry out harvesting of mopane worms once during each harvesting season while 25% does harvesting twice in a season. The worms are mostly available during the rainy season when the mopane trees refresh their leaves. Those who harvest twice would go for the first harvest camping and come back and go for a second camping within the same season. This is largely dependent upon availability of the mopane worms within this season.

4.3.1.3 Method of harvesting of Mopane Worms

The most prominent methods of harvesting of the mopane worms within the study area was shaking of the trees and picking the worms from the ground by 57% of the harvesting respondents. The remaining 20% wait for the mopane worms to climb down the trees and pic. 18% climb the tree and pick worms whilst 5% cut the host tree to pick the worms. Cutting of the trees is highly discouraged by the owner of the woodlands and the local leadership and

environmental authorities. The main practised methods are regarded as environmentally sustaining as they are less destructive to the vegetation.

4.3.1.4 Processing of Mopane Worms

Processing of the mopane worms is usually a responsibility of the women with 82% of the responses. Processing of food materials is generally regarded as the responsibility of the women according to gender norms.

4.3.1.5 Quantities of Harvests per Season

Quantity of harvest per season largely depend on the mopane worm's availability due to the nature of the season and due to the capacity of the family or the participant to harvest. Generally, the minimum harvest per season is 2 by 20l buckets to a maximum of 16 buckets. The average yield noted was 5 buckets of mopane worms.

4.3.2 Marketing of Mopane Worms

4.3.2.1 Method of Trading of the Mopane Worms

The largest proportion of the off takers of the mopane worms were the local market. Selling at home takes 26% and selling by the roadside has 16% of the participants. Selection of the market is mainly dependent on the ease of market access and the cost of marketing hence most relied on the local market due to its relatively lower costs in terms of access. The participants lack access to bigger formal markets due to the distances encountered, poor roads, licence requirements and cost of transport services to access the lucrative markets. The local markets carry comparatively minimal marketing costs but not withstanding the low financial rewards from the local market due to limited numbers of off takers.

4.3.2.2 Marketing Channels for Mopane Worms

A significant proportion of the harvested mopane worm is marketed through the middlemen for 75% of the participants while only 25% is done by the harvesters themselves. The middlemen market the mopane to wholesalers who then package for their own marketing. This is mainly because of the limitation in access to the high value market by most mopane harvesters and the need to address the immediate family food and livelihoods needs and the middlemen offer ready cash that addresses all these immediate family needs.

4.3.2.3 The Pricing of the Mopane worms per given Quantity

The minimum price traded per 20 litre bucket was R150 and the maximum being R350 with an average of R300/ bucket. The prices dependent on the availability of the market and seasonality factors where mopane worms cost more when its off- season and prices drops when the market has a glut. Most of the off- takers of the mopane worms are the middlemen who absorb quite a significant quantity of the mopane worms. These middlemen have significant power and determine the prices upon which they can take the mopane worms. The harvesters are generally price takers due to their desire to address their immediate family needs.

4.3.3 Incomes from Mopane Worms

4.3.3.1 Income from Mopane Worms

Comparing the income levels of mopane harvesting families against non- harvesting families shows that mopane harvesters are concentrated in incomes above R1000 when non- harvesting families are earning average season incomes below R1000 per season.

Table 1: Comparison of Income from Mopane Worms for harvesters and non- harvester

	<450	451- 1000	1001- 2000	2001- 4000	above 4000
None-harvester	1	27	16	5	1
Harvester	0	1	7	25	17
Total	1	28	23	30	18

The results show that mopane harvesting families have comparatively better incomes when compared to non- mopane harvesting families implying that participation in mopane harvesting influence the level of incomes of the participating households. The following section show results on significance test on the comparison of the incomes between mopane harvesting families and non- harvesting families.

4.3.3.2 Effect of Mopane worm harvesting on household income.

Since $p < .001$ is less than our chosen significance level $\alpha = 0.05$, we reject the null hypothesis, and conclude that the that the mean income for mopane harvesters and non-harvester is significantly different. Based on the above results, the researcher can state that there a significant difference in incomes between non-harvesters and harvesters of mopane worms ($t_{90.012} = 4.169$, $p < .001$). The difference in incomes between mopane harvesting and non-

harvesting families is significant because of the homogeneity in groups rather than by random effect. It is therefore, apparent that participation in mopane worms would generally result in improved incomes for the participating households.

Table 2: Effect of Mopane worm harvesting on household income.

Group Statistics

	Mopane worm harvester (Y/N)	N	Mean	Std. Deviation	Std. Error Mean
Total HH income including from sale of mopane	Yes	50	3191.92	1332.657	188.466
	No	50	2216.60	980.160	138.616

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Total HH income including from sale of mopane	Equal variances assumed	5.966	.016	4.169	98	.000	975.320	233.953	511.049	1439.591
	Equal variances not assumed			4.169	90	.000	975.320	233.953	510.533	1440.107

4.3.4 Mopane Worm Harvesting and Household Food Security

Food security of the household can be measured by assessing the number of meals and the use of proxy food security indicators such as the Dietary Diversity Score which determines access to diversified food groups within a 24-hour recall period. The sections below show results on the DDS comparisons between mopane harvesting families and non- harvesting families.

4.3.4.1 Household dietary diversity of Mopane Worm harvesting and non-harvesting households.

The average dietary diversity for those who harvest mopane worms was 8.78 while that of non-harvesters was 4.4 implying that families that harvest mopane eat a wider variety of food groups compared to non- harvesting families who eat a fewer food groups. This is mainly because mopane-harvesting families have better incomes from mopane sales which they generally use to acquire more food groups when compared to the non- harvesters. The average number of meals for mopane harvesters was 1.98 while that for non- harvesters was 1.18 per day.

4.3.4.2 Effect of mopane worm harvesting on Household Dietary Diversity

Since $p < .001$ is less than our chosen significance level $\alpha = 0.05$, we reject the null hypothesis, and conclude that the that the mean dietary diversity intakes by mopane harvesters and non-harvester is significantly different. Based on the results, we can state that there was a significant difference in dietary diversity intakes between non-harvesters and harvesters of mopane worms ($t_{95.134} = 18.288$, $p < .001$). The fact that mopane harvesters eat a wider variety of food groups when compared to non- harvesting households is due to the homogeneity among the group of mopane harvesters and heterogeneity of characteristics between groups and not by random sampling. We can safely conclude that if a household participate in mopane worm harvesting, it will generally result in improved diets for their families based on direct consumption of mopane worms and availability of funds to purchase other food groups.

Table 3: Effect of mopane worm harvesting on Household Dietary Diversity

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
DDS	Equal variances assumed	2.654	.107	18.288	98	.000	5.34000	.29200	4.76053	5.91947
	Equal variances not assumed			18.288	95.134	.000	5.34000	.29200	4.76031	5.91969

Group Statistics

	Mopane worm harvester (Y/N)	N	Mean	Std. Deviation	Std. Error Mean
DDS	yes	50	8.7800	1.58166	.22368
	no	50	3.4400	1.32727	.18770

4.3.4.3 Effect of mopane worm harvesting on meal frequency.

Since $p < .001$ is less than our chosen significance level $\alpha = 0.05$, we reject the null hypothesis, and conclude that the that the mean meal frequencies by mopane harvesters and non-harvester is significantly different. Based on the results, we can state that, there was a significant difference in meal frequencies between non-harvesters and harvesters of mopane worms ($t_{6.961} = 6.961$, $p < .001$). Mopane harvesting families have better access to food and therefore, eat more meals when compared to non-harvesting families.

Table 4: Effect of mopane worm harvesting on meal frequency.

Group Statistics

	Mopane worm harvester (Y/N)	N	Mean	Std. Deviation	Std. Error Mean
Frequency of meals	yes	50	1.9800	.68482	.09685
	no	50	1.1800	.43753	.06188

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Number of meals	Equal variances assumed	4.135	.045	6.961	98	.000	.80000	.11493	.57193	1.02807
	Equal variances not assumed			6.961	83.289	.000	.80000	.11493	.57143	1.02857

4.3.5 Household coping strategies to food insecurity

4.3.5.1 Percentages of households employing each coping strategy in response to food inadequacy.

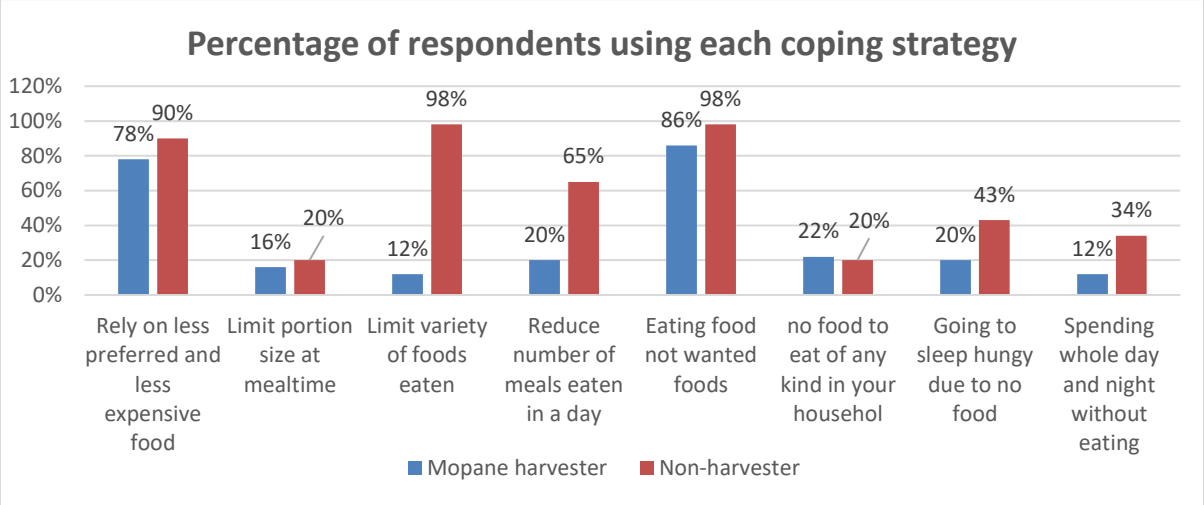

Figure 1: Percentages of households employing each coping strategy when faced with food shortage.

The graph above shows that there are more households employing many of the coping strategies within the non- mopane harvesting category when compared to the mopane harvesting families. More non- mopane harvesting households rely on less preferred and less expensive food stuffs when compared to mopane harvesting households. There are also more of the non- harvesting households limiting the varieties of food, reducing number of meals, eating unwanted foods, going to sleep on empty stomachs and spending the whole day without eating when compared to less households within the mopane harvesting categories. Based on the above results, mopane harvesting families employ lesser of the coping strategies when compared to non- harvesting families. This is mainly because of enhanced to incomes for the harvesting families. The mopane harvesting families, therefore, have a comparatively better food security level when compared with the non- harvesting families.

4.3.5.2 Effect of mopane worm harvesting on meal number of Coping Strategies employed by households.

Since $p < .001$ is less than our chosen significance level $\alpha = 0.05$, we reject the null hypothesis, and conclude that the that the frequencies of drought coping strategy methods among mopane harvesters and non-harvester is significantly different. Based on the results, we can state the following there is a significant difference in the frequencies of drought coping strategy methods

between non-harvesters and harvesters of mopane worms ($t_{81.553}$= -5.365, p < .001). Mopane harvesting households employ lesser coping strategies to survive food shortage situation when compared with non- harvesting families that are employ more strategies when faced with food inadequacies.

Table 5: Effect of mopane worm harvesting on meal number of Coping Strategies employed by households.

Group Statistics

	Mopane worm harvester (Y/N)	N	Mean	Std. Deviation	Std. Error Mean
Times for coping strategies	yes	50	2.9000	1.05463	.14915
	no	50	3.8400	.65027	.09196

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Times on a	Equal variances assumed	5.170	.025	-5.365	98	.000	-.94000	.17522	-1.28772	-.59228

coping strategy	Equal variances not assumed			-5.365	81.553	.000	-.94000	.17522	-1.28860	-.59140

4.5 Conclusion

The results have shown that the middlemen play the major role in the marketing of the mopane worms and harvesters are generally price takers due to a myriad of challenges within the marketing systems. Households that participate in mopane worms harvesting have better incomes, eat more meals, and have a diversified diets implying that mopane worms influence the food security levels of the households. Mopane worms harvesting and marketing may be used on government poverty reduction policy designs and community work programming to help enhance the food security and livelihoods efforts of the disadvantaged communities.

CHAPTER 5
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarises the findings from the research. It also elaborates the implications to the subject under the study and brings to the fore some of the possible recommendation to the community and to the authorities for enhanced food security, livelihoods, and sustainability. The study was contacted to 50 mopane worm harvesters and 50 non- mopane worm harvesters for the researcher to make a comparison of the results of the two groups.

5.2 Research summary

This research summary provides brief details of the study. The research is meant to evaluate the effect of mopane worms harvesting and marketing on the household food security and livelihoods statuses of participating households in ward 15 of Mwenezi District. The research focused on mopane harvesting families and non- harvesting families within the same

geographic locations. The research evaluated the available marketing channels used by mopane worm harvesting households as well as the effect to the household incomes and food security with particular emphasis on the access to dietary diversity, coping strategies and meal frequencies. Comparative analysis was used on food security and livelihoods aspects between mopane- harvesting families and non- harvesting families.

Results of the research have brought out that the research participants are into farming and few into buying and selling, cross- border trading. The main source of income within the study area is selling of grain, mopane worm trading, trade, and livestock sales. Sale of mopane worms is a major activity to most of the community as it is considered a major livelihood source for households within the community. The most prominent method of mopane harvesting is shaking of the trees for the worms to fall then pick into sacks and baskets. The least method is cutting down of the trees. The main method of harvesting is regarded as safe and sustaining as it is less likely to result in deforestation. The main harvesting period when the mopane worm is fully matured is normally from February to March. Harvesters go for weeks on the mopane harvesting season. Harvesting is generally done once within each season. Women constitute the majority who do the harvesting of the worms with the least done by boys. Women and girls are mainly responsible for processing of the worms including drying. There is no training done in relation to the exploitation of this natural resource and there is a possible chance of unsustainable utilisation of the resource. None has a mopane harvesting certificate.

Most of the mopane worm harvesters sell locally to mainly the middlemen as this have the minimum possible marketing costs. Most of the mopane harvesters are price takers as the marketing options are limited by transport network and availability to access high value markets. The average price off taker price is R300/ bucket. The high value markets have stringent regulatory requirements which the harvesters do not have. The average yield per harvester is around 4.6 by 20litre buckets within a season. Trading of the mopane worms is normally in the rand currency. The incomes from the sale of mopane worms ranged from R300 to R4800 and an average R2409. Mopane worm harvester have comparatively higher incomes when compared to none- harvesters and the differences in income levels are statistically significant from the significance tests done. The dietary diversities of those harvesting mopane worms are generally higher than the non- harvester. Mopane harvesters have more meal frequencies when compared to non- harvesters. Mopane harvesters employ lesser number of coping strategies in response to shortages of food at household level. This implies that the

general food security of harvesters is better than that of non- harvester and as such utilisation of mopane worms contribute to enhanced food security at household level.

5.3 Conclusion

The households involved in the harvesting and trading of the mopane worms have comparatively better incomes, dietary diversity scores, meal frequencies when compared to the non- harvesters. The harvesters employ a lesser number of coping strategies when faced by shortages of food at household level. Utilisation of the mopane worm helps enhance the general livelihoods of the participating households. Mopane worm business can be used a poverty reduction strategy targeting communities in Mwenezi where there are mopane woodlands.

5.4 Policy implication and recommendations

The study implores the government to incorporate mopane harvesting, processing and trading as a rural poverty reduction strategy that can help address some of the vulnerability challenges prevalent within the communities. The effort should incorporate plugging the noted gaps in mopane worm business to help it benefit the affected communities more. There is need to develop poverty reduction policies that help educate the community with regards to utilisation of natural resources to avoid depletion of the mopane parent stock as is evident in main areas where we find mopane woodland. Mopane harvesters need to be trained on marketing, financial inclusion, value addition and environmental protection issues. The mopane worm harvesters need to be capacitated through formal certification to enable them to participate in the formal market systems to realise better incomes.

5.5 Areas for further research

The study recommends further research on the following areas that were not covered by the study:

1. Mopane Worm Value- Chains and possible processing opportunities into other high value products for human and livestock consumption.
2. Study on the mopane marketing options capitalising on the local corridors and possible market integrators to create opportunities for many of the harvesters within the district.
3. Research on the nature of depletion of the parent stock in most mopane woodlands in Beit Bridge. Gwanda and Mwenezi District. This would help inform authorities to craft strategies to rejuvenate availability of the natural resource to most of the mopane woodlands.

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Appendices:

Questionnaire

QUESTIONNAIRE ON AN EVALUATION OF THE HARVESTING AND MARKETING OF MOPANE WORMS AND ITS EFFECT ON THE INCOMES AND DIETARY DIVERSITY OF HOUSEHOLDS IN MWENEZI DISTRICT.

My name is Brian Mudzoki. I am a student at Bindura University of Science Education studying for a Master of Science Degree in Food Security and Sustainable Agriculture. I am doing an Evaluation of the Harvesting and Marketing of Mopane worms and its Effects on the Incomes and Dietary Diversity of households. May you provide me with the relevant information to the questions below. The interview may take a maximum of 30 minutes. The recommendations of the study are going to be shared with academic community, mopane worm harvesting communities, mopane worm traders, policy makers and nutrition expects.

All information provided by interviewee will be treated as STRICTLY CONFIDENTIAL for mutual benefit of both the researcher and the respondents.

Enumerator name……...…… Name of respondent……
District name…….. Village name…….....
Ward……..... Date...…….....

A. HARVESTERS AND OR NON -HARVESTERS DEMOGRAPHIC AND SOCIO ECONOMC INFORMATION
1. Head of household

a. Gender	Male			Female	
b. Age					
c. Marital status	Married	Single		Divorced	Widowed
d. Highest level of education of household head					
	No formal or informal education	Informal education	Primary	Secondary	Tertiary education
e. Highest level of education of any household member					
	No formal or informal education	Informal education	Primary	Secondary	Tertiary education
2. What is your principal occupation?					
3. Are you a Mopane worm harvester? YES NO					

4. What is the size of your household?		Adults (≥18)	Children (<18)
	Male		
	Female		

4. What are your sources of income? (Rank 1 as the most important source of income)

	Source	**Amount in the last 4 weeks**	**Rank**
	Crops		
	Sale of Mopane worms		
	Livestock		
	Poultry		
	Vegetables		
	Pension/grants		
	Trade (transport, resale of goods)		
	Sale of wild foods		
	Craftwork (mats, baskets, pots)		
	Community projects		
	Other (specify)		

5. What method are you using to harvest Mopane worms? *Multiple answers possible*

- **(a)** Waiting for the mopane worms to climb down and pick
- **(b)** Climb the trees and pick
- **(c)** Cutting down the trees and pick
- **(d)** Shacking rigorously the trees and pick those that fall

5. 1	**Who amongst the family members does the harvesting?** **(a)**men (b) girls (c) women (d) boys (e) the elderly (f) all family members	
5.2	**How often (frequency) do you harvest Mopane worms per week?**	
5.3	**Who does the processing of Mopane worms in your household**?	
5.4	**How much Mopane worms does your household harvest per season?**	
5.5	**Have you ever received any training about Mopane worms? If Yes, which ones.** (a) Sustainable harvesting of mopane worms (b) Regulatory procedures of mopane worm (c) Mopane worm trading as a business (d) Nutritional value of mopane worms (e) Any other, specify	
5.6	**Who provided the training?**	

	(a)EMA (b) NGOs (c) AGRITEX (d) Local Authority (e) any other, specify	
5.7	**Do you have a Mopane worm harvesting permit?** (a) No (b) Yes (c) Processing	
5.8	**What are the trading methods that you are using?** (a) Farm-gate (b) road side (c) wholesale (d) local market (e) any other..	
5.9	**How are you charging (pricing) per what quantity?**	
6.0	**How much income do you realize per season from Mopane worm sales?**	
6.1	**What is your average annual income from all sources including that from selling of mopane worms**	

B. HOUSEHOLD FOOD SECURITY STATUS

1. What are your sources of food? (Rank 1 as the most important source of food)

Own crop production	Purchase	Wild food collection	Food aid
Own livestock products	Barter	Food for work	Steal
Mopane worms	Gifts of food	Loans	Stocks
Food at school	Fishing	Hunting	Friends/relatives
Other sources of food(Specify):			

2. What types of foods did you or anyone else in your household ate yesterday during the day and night at your home.(didn't eat=0 and ate=1)

Any foods made from maize, wheat, rice or any other locally available grain e.g samp, pap, bread	
Any potatoes or any other food made from roots or tubers,	
Any vegetables	
Any fruits	
Any meat, poultry, offal or Mopane worms	
Any eggs	
Any fresh or dried fish and seafood	
Any foods made from beans, peas or nuts	
Any cheese, yogurt, milk or other milk products	
Any food made from oil, fat or butter	
Any sugar or honey	
Any other foods such as coffee, tea and condiments	

3. On average, how many meals do you have per day? **4. How often do you consume Mopane worms within 7 days**		
5. Do you think you have access to enough food?	Yes	No

6. How do you rate your level of access to food nowadays as compared to last year?

No change	Better	Fair	Worse off

Please note:
Question 7 is about food accessibility in the past 4 weeks (1 month)

7. If yes to the following questions, How often did this happen?
0= Never**; 1** = Rarely (once or twice in the past four weeks); **2** = Sometimes (three to ten times in the past four weeks); **3**= Often (more than ten times in the past four weeks)

a. Did you worry that your household would not have enough food?	
b. Were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	
c. Did you or any household member have to eat a limited variety of foods due to a lack of resources?	

d. Did you or any household member have to eat some foods that you really did not want because of a lack of resources to obtain other types of food?	
e. Did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	
f. Did you or any household member have to eat fewer meals in a day because there was not enough food?	
g. Was there ever no food to eat of any kind in your household because of lack of resources to get food?	
h. Did you or any household member go to sleep at night hungry because there was not enough food?	
i. Did you or any household member go a whole day and night without eating anything because there was not enough food?	

8. When do you encounter food shortages? (you may tick more than once)

Any time of the month	Just before month end	Before harvesting	After drought	**Other times:**

9. What is causing food shortages in your household? (Rank)

Income not increasing at the rate of inflation	
Poor harvest due to drought	
Poor harvest due to high temperatures	
Poor harvest due to low temperatures (snow)	
Poor harvest due to pests and diseases	
Poor harvest due to hail storm	
Poor harvest due to late rainfall	
Loss of livestock due to pests and diseases	
Loss of livestock due to snow	
Loss of livestock due to drought	
Loss of livestock due to high temperatures	
Lack of water sources/reservoirs	
Lack of agricultural inputs	
Poor salaries	
Retirement	
Retrenchment	
Grants not increasing at the rate of inflation	
Increase in household size	
Death of the main food provider	
Other (specify)	

10. What adjustments or possible solutions have you made to feed the infants in your household? (you may tick more than one option)

Coping strategy in the past 7 days	**Frequency; No of days you adopted coping strategy (0-7days) use NA if not applicable**
Rely on less preferred or less expensive foods?	
Borrow food or rely on relative?	
Purchase food on credit?	
Gather wild food, hunt or harvest immature crops?	
Consume seed stock held for next season?	
Reduce the number of meals per day?	

Limit portion size?			
Send children to eat elsewhere?			
Send children to beg?			
Restrict consumption by adults for small children to eat?			
Other adjustment mechanisms:			
11. On average, what percentage of your income did you spend on food?			
<25%	25%-50%	51%-75%	>75%

THANK YOU