

**Mopane worms and household food security in the Limpopo Province, South Africa**

**By**

**Beatrice Bosompemaa Oppong**

**Submitted in partial fulfilment of the degree of  
Master of Science in Agriculture (Agricultural Economics)  
School of Agricultural, Earth and Environmental Sciences  
College of Science and Agriculture  
University of KwaZulu-Natal  
Pietermaritzburg**

**NOVEMBER 2013**

## **ABSTRACT**

The main objective of this study is to examine the potential contribution of households' involvement in mopane worm activities (harvesting, commercialisation and consumption) to households' food security in the Mopani District of the Limpopo Province. Data was collected using a structured questionnaire from a stratified sample of 120 households, 60 of which are mopane worm harvesters. The Binary Logit Model was used to determine households' socio-economic factors affecting participation in mopane worm harvesting. The results revealed that gender of the household head, age of the respondent, households' size and the level of income per month increases the probability of households participating in mopane worm harvesting whilst distance to the market and food expenditure as well as religion (belonging to the Zion Christian Church) decreased the probability of being mopane worm harvester.

The Ordinary Least Square (OLS) model was used to identify households' socio-economic factors that determine the rate of commercialisation of mopane worms within harvesting households. 53 percent of the households commercialized their harvest. The model identified that gender, harvesting experience and income from mopane worm sales are the main factors determining commercialisation within harvesting households.

The Household Food Insecurity Access Scale (HFIAS) was used to determine household food security status. The result revealed that about 20 percent of the harvesters were food secure, while 80 percent were food insecure. In addition, about 12 percent of the non-harvesters were food secured. An OLS model was also used to examine the impact of mopane worms in the food security status of the households in the Limpopo Province. The results revealed that age, education level of a household head, level of income, income from mopane worm sales and

frequency of consuming mopane worm/day improve the food security status of households whilst households' size and the distance to the market worsens the food security status of the households. The study found that about 48 to 60 percent of the households to be adopting less pervasive strategies like asking neighbours/family relatives for help, borrowing money for food and selling mopane worms for cash to protect their food consumption and over 70 percent adopted strategies like reducing food intake, portion size and eating less preferred food were adopted to modify their food consumption. The findings indicated that policy priorities should be focused on the promotion of harvesters associations for collective marketing and creating an enabling environment for sustainable harvesting and commercialisation.

## DECLARATION

I Beatrice Bosompemaa Oppong hereby declare that this thesis is my own work and has never been submitted to any University for the award of a Degree

Signed .....  
Beatrice Bosompemaa Oppong

Date.....

This thesis has been submitted with our approval as university supervisors.

Signed .....  
Dr Lloyd Baiyegunhi (Supervisor)

Date.....

Signed .....  
Ms Grany Mmatsatsi Senyolo (Co-Supervisor)

Date.....

## **ACKNOWLEDGEMENT**

I want to thank my parents Charles and Mercy Oppong for their prayer, love encouragements and unalloyed support—I love you so very much; your devoted energies and struggle to see me become who I am today will always be remembered. And to my siblings for being pillars of strength for me during my period of study, and for the years I have been far away from home; you are source of inspiration to me. To all my friends especially those whose names are not here mentioned, thank you for your encouragement. It is through your support that I have managed to complete this study.

I also owe an enormous depth of gratitude:

- to my supervisors Dr. Lloyd Baiyegunhi (PhD) and Ms Grany Mmatsatsi Senyolo (MSc) for your immense guidance, contributions, patience and constructive comments;
- to the UKZN bursary funding department and the respondents for support and contribution towards making this study a reality; thank you for your participation;
- To Mr Okoye, Felix Ifeanyi (MEd), your academic contributions is highly appreciated;
- To my love; please thank you for the person you are and may God continue to bless you.

Finally, my sincere thanks go to my family: Vincent, Ronald, Sarah, Ray, Rev Larry Odonkor and wife. Thank you for your immense support and for being there for me always. I would not have achieved this phenomenal success without the love, support and encouragement of all the people I have mentioned and not mentioned. I take my hat off for each and every one of you! Thank you so very much and please keep the good work.

## **DEDICATION**

This dissertation is dedicated to my family and to God Almighty

## TABLE OF CONTENT

ABSTRACT.....	i
DECLARATION .....	iii
ACKNOWLEDGEMENT .....	iv
DEDICATION.....	v
TABLE OF CONTENT .....	vi
LIST OF TABLES .....	x
LIST OF FIGURES .....	xi
ACRONYMS.....	xii
CHAPTER 1 .....	1
INTRODUCTION .....	1
1.1        Background.....	1
1.2        Problem statement.....	4
1.3        Objectives of the study.....	6
1.4        Hypotheses .....	6
1.5        Justification of the study .....	7
1.6        Chapter overview .....	8
1.7        Limitations of study .....	8
1.8        Conclusion .....	9
CHAPTER 2 .....	10
LITERATURE REVIEW .....	10
2.0        Introduction.....	10
2.1        Mopane worm harvesting .....	10

2.1.1	Socio-economic factors affecting mopane worm harvesting.....	11
2.1.2	Mopane worm commercialisation.....	14
2.1.3	Factors affecting mopane worm commercialisation .....	15
2.2	Concept and definitions of food security .....	17
2.2.1	Dimensions of food security .....	18
2.3	The state of food security in South Africa .....	20
2.3.1	Factors affecting food insecurity .....	23
2.4	Mopane worms and households food security .....	26
2.5	Contribution of mopane worms to household food security.....	27
2.5.1	Indirect contribution of mopane worms to household food security .....	28
2.5.2	Direct contribution of mopane worms to food security .....	29
2.6	Household coping strategies to improve food security.....	30
2.6.1	Strategies to protect food consumption.....	31
2.6.2	Strategies to modify food consumption .....	32
2.7	Conclusion .....	33
CHAPTER 3 .....		34
METHODOLOGY .....		34
3.0	Introduction.....	34
3.1	Study area.....	34
3.2	Sampling technique.....	37
3.3	Methods of data collection.....	38
3.4	Data analysis techniques .....	38
3.4.1	Binary logistic regression households' participation model.....	38



3.4.2.	The mopane worm commercialisation model.....	41
3.4.3	Mopane worms and household food security model .....	44
3.5	Conclusion .....	48
CHAPTER 4 .....		48
FACTORS AFFECTING HOUSEHOLDS’ PARTICIPATION IN MOPANE WORM ACTIVITIES.....		49
4.0	Introduction.....	49
4.1	Households’ socio-economic characteristics .....	49
4.1.2	Socio-economic factors affecting household’s participation in mopane worm activities .....	51
4.2	Mopane worm harvesting, and commercialization.....	55
4.2.1	Determinants of mopane worm commercialisation among harvesters .....	56
4.3	Conclusion .....	60
CHAPTER 5 .....		61
CONTRIBUTION OF MOPANE WORMS TO HOUSEHOLD FOOD SECURITY .....		61
5.0	Introduction.....	61
5.1	The incidence of household food insecurity .....	61
5.2	Factors influencing household food insecurity .....	63
5.3	Coping strategies to combat households’ food insecurity .....	68
5.3.1	Strategies to protect food consumption.....	68
5.3.2	Modifying food consumption to cope with food insecurity.....	70
5.4	Conclusion .....	71

CHAPTER 6 .....	72
SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS .....	72
6.0        Introduction.....	72
6.1        Summary .....	72
6.2        Conclusion .....	74
6.3        Policy recommendations .....	75
6.3.1    Possible research foci for individual studies.....	77
REFERENCES .....	78
APPENDIX 1 .....	86
APPENDIX 2.....	91

## LIST OF TABLES

Table 1:	Scores for food security, risk of hunger and experience of hunger (food insecurity) using data from four national surveys, South Africa 2012 .....	20
Table 2:	Food insecurity within the Provinces of South Africa.....	23
Table 3:	Definition of variables included in the logistic model.....	41
Table 4:	Definition of variables included in the commercialisation model .....	44
Table 5:	Definition of variables included in the food security model.....	48
Table 6:	Households' socio-economic characteristics .....	50
Table 7:	Results of the logistic regression model for factors affecting participation. ....	52
Table 8:	Mopane worm commercialisation variables .....	56
Table 9:	Estimated coefficients of the linear regression model for commercialisation .....	57
Table 10:	Food security status of households in the Limpopo Province .....	62
Table 11:	Determinants of household food insecurity .....	64
Table 12:	Households coping strategies to protect food consumption .....	69
Table 13:	Household strategies to modify food consumption .....	70
Table 14:	HFIAS module .....	86
Table 15:	HFIAS indicator guide.....	86
Table 16:	Binary logit regression model output.....	87
Table 17:	Mopane worm commercialisation model output .....	88
Table 18:	Ramsey test for the commercialisation model .....	88
Table 19:	Household food security model output .....	90
Table 20:	Ramsey test for the food security model.....	90

## **LIST OF FIGURES**

Figure 1:	Conceptual framework of the contribution of mopane worms to food security ...	28
Figure 2:	A categorisation of coping strategies used by households.....	31
Figure 3:	The frequency distribution of households HFIAS Scores .....	62
Figure 4:	Normal P-P plot for the commercialisation model .....	89
Figure 5:	Normal P-P plot for the commercialisation model .....	89

## **ACRONYMS**

CCHIP	Community Childhood Hunger Identification Project
FAO	Food and Agriculture Organisation
HFIAS	Households Food Insecurity Access Scale
HFIAP	Household Food Insecurity Access Prevalence
NTFP	Non Timber Forest Products
SAFIRE	Southern Alliance for Indigenous Resources
SANHANES	South African National Health and Nutrition Examination Survey
US HFSSM	U.S. Household Food Security Survey Module
WHO	World Health Organisation
ZCC	Zion Christian Church

# **CHAPTER 1**

## **INTRODUCTION**

This chapter outlines the problem, objectives, and the hypotheses this study aims to address. It also presents a background and a brief overview of dissertation structure. It concludes by raising the issues the reader can expect in subsequent chapter.

### **1.1 Background**

Food security is defined by the Food and Agriculture Organization (FAO) as a condition when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. That is, food must be available (stable and sustainable food supply), accessible (affordable) and utilized in a safe manner to ensure a healthy lifestyle (FAO, 2010). Ironically global reports on food have shown a long-term persistent lack of adequate food; whereby nations and people are constantly at risk of being food insecure (a situation where communities or societies have exhausted all their purchasing resources, food stocks and usual hunger coping mechanisms) (FAO, 2009).

Over the past two decades, the number of food insecurity emergencies has risen from an average of 15 per year in the 1980s to more than 30 per year from 2000 onwards (FAO, 2010). For instance, the Food and Agriculture Organization (FAO) in 2011, estimated about one billion hungry people globally which approximates to 1 out of every 7 people worldwide (FAO, 2011). According to the (FAO, 2011), major human induced food insecure emergencies persisting for several years are known as protracted emergencies and the vast majority of protracted crises are in Africa, where the average number of crises has tripled over the last two decades. These crises are propelled mainly by armed conflict, often compounded by drought, floods and the effects of

the HIV/AIDS pandemic (FAO, 2009). The impact on food production and food security has been dire for millions of people who are driven from their homes, unable to work their fields, cut off from markets for their produce and from commercial supplies of seed, fertilizer and credit (FAO, 2010).

In South Africa, the combined effects of HIV/AIDS infection, high rates of illiteracy, population growth and high rural settlements have eroded household's ability to access adequate food that ensures a healthy lifestyle (Sakyi, 2012). Based on the 2013 report from the South African National Health and Nutrition Examination Survey (SANHANES) about 54 percent of South African households are food insecure, of which about 70 percent occurred in rural formal and informal areas of South Africa (Shisana *et al.*, 2013). This shows the high impact of geographical settlements in ensuring households access to food in South Africa. Some authors stresses that, the food insecurity situation in South Africa is not only as a result of poor crop harvest but also mainly due to high domestic prices, lower incomes and unemployment (Altman *et al.*, 2009 and Aliber, 2009). Others attribute high unemployment rate and inadequate social welfare systems as the main contributors to household food insecurity in South Africa (De Cock *et al.*, 2013 and Sakyi, 2012).

According to the Food and Agriculture organization (FAO), the recurring global population increase and the increasing demand of food has led to a momentum increment in the research on Non Timber Forest Products (NTFP) like edible insects as a potential food source (FAO, 2003). Several investigations have shown that, in addition edible insect's fundamental contribution for pollen dissemination, edible insects may have the potential to contribute to household food security (Shackleton & Shackleton, 2004; De Foliart, 1995; Lucas, 2010).

More than 200 million Africans consume insects regularly. Insects have been seen to provide a direct contribution to food and nutrition security through their high protein and calorie content (Timberlake, 1996). In South Africa human consumption of insects as food is more prominent in the warmer provinces such as Mpumalanga, North West, Limpopo and Gauteng. Those most commonly consumed insects are grasshoppers, termites, bees, mopane worms, stink-bugs, jewel beetles and white-grubs (De Foliart, 1995 and Taylor, 2003). However, the mopane worm has been documented to be the most widely consumed and economically important forestry resource product within these provinces. The mopane worm *Imbrasia Belina* are the caterpillar stage of the emperor moth *Gonimbrasia Belina* found on the mopane tree *Colophospermum mopane* within the mopane woodlands of South Africa, Botswana and southern Zimbabwe (Timberlake, 1996).

Over large parts of northern South Africa (Limpopo Province), mopane worms harvesting for subsistence plays a central role in sustaining human well-being. For those who cannot afford to buy food especially, mopane worms obtained through household's own harvesting efforts (subsistence) is essential; it can make a difference between good and bad nutrition, between recovered health and prolonged illness or between food security and starvation. Taylor (2003) added that, while mopane worms as a subsistence product is an important source of direct food security for harvesting households, the incomes generated from wages in the mopane worm trade is often even more important as an indirect contribution to food security.

In the 1990s, hundreds of tons of mopane worms were exported annually from Botswana and South Africa to Zambia and Zimbabwe (De Foliart, 1992; Thomas, 2013 and Ghazoul, 2006). Stack *et al.*, (2003) reported that an estimated 1.6 million kilograms of mopane worm were traded by South Africa alone annually, and Botswana's involvement in the mopane worm trade



industry nets the country about \$8 million annually. The mopane veld in South Africa covers about 20,000km<sup>2</sup> of land. This 20,000km<sup>2</sup> on annual basis can produce an estimated population of 9,500m mopane worms worth R 850, 721637.00 (Styles, 1994). De Foliart (1995) further added that, the mopane worm harvest in South Africa is estimated at R 387, 168000.00 million a year, of which approximately 40 percent goes to producers who are primarily poor rural women.

As a consequence of the good returns associated with mopane worm trading, and the fact that outbreaks occur in different areas from year to year, it is now common to find people using motorised transport to harvest mopane worms for commercial purposes and far from their local communities (Thomas, 2013). According to Rebe (1999) commercialisation of the mopane worm trade in southern Africa has led to over-harvesting with rural women now collecting substantially more than a single person would have traditionally harvested for family consumption alone. Apparent over-harvesting in South Africa has led to strong demands for imported mopane worms from Botswana (Moruakgomo, 1996; Thomas, 2013).

## **1.2 Problem statement**

Despite the numerous studies on the ecological benefits and the economic importance of mopane worms to household's livelihood management in southern Africa (Thomas, 2013; Hope *et al.*, 2009; Stack *et al.*, 2003), mopane worms are still underutilized. Reasons why the mopane worms have remained underutilized may be associated with the idea that people may not be familiar with the potential benefits that can be derived from participating in mopane worms activities or the perception that mopane worms activities have limited economic potential outside its areas of harvesting. However, several studies have shown that, mopane worm harvesting can provide food and income to households which may improve household's livelihood strategies and thus

translate to a better food security status (Stack *et al.*, 2003; Kozanayi and Frost, 2002 and Thomas, 2013). However, information on how mopane worms actually contribute to households food security has been scanty, the few studies that have looked at mopane worm in terms of food security, have been focused on the use of mopane worms activities as a household livelihood strategy and not necessary on the relationship between the mopane and household food security (Stack *et al.*, 2003; FAO, 2003; Styles, 1994; Mpuchane *et al.*, 2000; Kozanayi and Frost, 2002; Thomas, 2013). In addition, most of these studies on the mopane worm and food security are mostly carried out in Zimbabwe, Botswana and the Vhembe district of the Limpopo Province. This is one of the very few studies to be conducted in the Mopani district of the Limpopo Province concerning mopane worms and households food security. This study aims to analyse the potential benefits that can be derived from households participation in mopane worm activities (harvesting, commercialisation and consumption) and its association to the households food security by examining the impact of mopane worms activities on households income generation, and the actual relationship between mopane worm activities and food security status of the household involved by answering the following questions;

- (i) what are the socio-economic characteristics of households involved in mopane worm activities?
- (ii) what are the household's socio-economic characteristics that determines the rate of commercialisation of mopane worms within harvesting households.
- (iii) what is the relationship between mopane worm activities (harvesting, commercialization and consumption) and household food security?

### **1.3 Objectives of the study**

The main objective of this study is to examine the contribution of mopane worms to household food security.

The specific objectives are to;

- (i) determine households' socio-economic factors affecting participation in mopane worm harvesting
- (ii) identify household's socio-economic characteristics that determine the rate of commercialisation of mopane worms within harvesting households.
- (iii) examine the impact of mopane worms in the food security status of the households in the Limpopo Province.

### **1.4 Hypotheses**

The hypotheses put forward for the study are as follows;

- (i) socio-economic factors such as age, gender of the household head, level of income, and distance to the market do not affect participation in mopane worm harvesting.
- (ii) household socio-economic factors such as age, gender of the household head do not determine the rate of mopane worm commercialization among harvesting households.
- (iii) mopane worm activities (harvesting, commercialisation and consumption) does not have any impact on the food security status of households in the Limpopo Province.

## **1.5 Justification of the study**

The 2013 South African National Health and Nutrition Examination Survey (SANHANES) report published in Shisana *et al.*, (2013) characterized Limpopo province as one of the poorest provinces in South Africa with higher rates of food insecurity (30.8 percent). However, this province has been home to one of the economical and nutritionally important insect in Southern Africa (The mopane worm). Most studies have reported on the effectiveness of the mopane worms harvesting (production) and consumption systems in improving household's income and ensuring households' food security (Mushongahande, 2003; Stack *et al.*, 2003). In particular, the harvesting and commercialization of mopane worms has contributed to improving the standard of living of villagers participating in it. For example, a study by Toms *et al.*, (2003) on mopane worms around the Kruger National Park of South Africa (Limpopo Province) showed the mopane worm's production system to be simple; whereby the worms are collected freely the mopane woodlands with minimal cost to the collector. Further, mopane worm production is usually a household affair whereby most of the incomes generated through the sales are spent on household commitments such as school fees and food. Therefore, examining the potential contribution of mopane worm activities within the dimensions of food security in an area with high levels of food insecurity (Limpopo Province) could help households reduce the high food insecurity in Limpopo province; by raising awareness on the direct and indirect benefits that can be derived from mopane worm activities.

Also understanding the role mopane worm activities play in household food security could help government in policies interventions aimed at reducing household food security in the Limpopo province as well as improving people's perception on mopane worms as a food crop.

## **1.6 Chapter overview**

Chapter one outlines problem, objectives, and the hypothesis this study aims to address. It also presents a background and a brief overview of dissertation structure, as well as the methodology adopted by this dissertation.

Chapter two provides a review of food security analysis, tracing the way in which the concept has changed in recent decades. A review of household food security measurements follows, with an analysis of changes resulting from history of South African insect consumption. The chapter concludes by highlighting the benefits derived from mopane worms' consumption.

Chapter three highlights the methodology adopted by the study to achieve the study objectives. Chapter four presents the results, discussions and analysis.

Chapter five furthers the analysis by exploring the contribution of mopane worms to household food security. This is to ensure that relevant issues are raised with regards to making viable recommendations.

Chapter six presents the conclusion, summary and then makes policy recommendations that emerge from the findings. It also recommends areas for further study.

## **1.7 Limitations of study**

This research had certain limitations that need to be taken into account when interpreting the results of the study. The study depended mainly on the information provided by the respondents during the administration of semi-structured interviews and simple visual observations. Both these sources are subjective and therefore may introduce certain biases, furthermore, the rate of households' participation in mopane worm activities are area specific and thus the potential

benefits that can be derived are also specific to the area depending on the outbreak of mopane worms in the area. Therefore, generalising the results of this study to other areas other the study area may be done with caution.

## **1.8 Conclusion**

This chapter focused attention on the orientation of the study. The next chapter however explores the local and international literature relevant to the study.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.0 Introduction

The review of relevant literature on the household's food security and mopane worm activities are presented in this chapter. The review is thematically divided into two sections whereby the first section (2.1) focuses on mopane worm activities (harvesting and commercialisation) and the socio-economic characteristics of households that affect these activities. While, the concepts of food security, the state of food security in South Africa and the Limpopo Province, factors contributing to household food security and the strategies households adopt to cope with households food insecurity are reviewed in the second section.

#### 2.1 Mopane worm harvesting

*Colophospermum mopane* commonly known as mopane worm is one of the dominant insect species harvested in the mopane woodland of South Africa (Oppong et al., 2009). According to Oppong et al., (2009) study on mopane worms, the harvesting of mopane worms entails their collection from both the ground and from trees, usually at the 5th instars stage and the last stage before pupation. The study further explains that mopane worms collected from the ground usually have little digested food in their guts and are easier to process. Ghazoul (2006)'s study on mopane worms and rural livelihoods added that, the preferred time for collecting the mopane worm larvae is when they are coming down off the tree for pupation. If they are collected at this time, no squeezing is required as the larvae empty their guts naturally before going underground. The study revealed that, mopane worm harvesting is marked by two climatic seasons, which partly intersect the biological cycle of the caterpillar: the dry season with final-stage larvae and

the wet season, when the pupae are matured for consumption. However, during the dry season the outbreak of mopane worms is less abundant and consequently more difficult to find. A study on mopane worm harvesting in Botswana by Lucas (2010) suggested mopane worm harvesting to depend on the host plant, culture and tradition of particular tribes involved. Therefore, the next section discusses the socio-economic characteristics that may affect households' participation in mopane worm harvesting.

### **2.1.1 Socio-economic factors affecting mopane worm harvesting**

Households are characterized by cultural and economic orientation towards mopane worm activities. A study by Stack *et al.*, (2003) on mopane worm utilisation and rural livelihoods in Southern Africa using the qualitative approach identified age and gender roles for different mopane worm activities for their study areas. Around the Mwenezi area in Zimbabwe, the study found about 80 percent of females as harvesters and above 33 years of age, and in the Botswana study area, the study found 96 percent as women harvesters above 33 years old and finally in other parts of Botswana, 8 percent of the harvesters' were female and above 60 years of age. However, the study reported more males harvesting mopane worms around the Mwenezi area than the Botswana area and was attributed to the poor functioning economy around the Mwenezi area. Thus men resort to mopane worms as a source of livelihood. Also, a study by Lucas (2010) on the evolution and impacts of mopane worm harvesting reported 91 percent of mopane worm collectors to be women and attributed the high participation of women to the fact that, rural men migrate to find better jobs outside their home towns and thus the women are left to attend to all household activities including mopane worm harvesting and farm work. Therefore, the study concluded that, depending on the study area, gender and age of the household head could greatly affect the kind of mopane worm activities the household will choose to participate in.



The study also found age of a household head to be an important factor that positively affects mopane worm harvesting. From Stack *et al.*, (2003), it is evident that, mopane worm harvesters are mostly above 30 years (33). An argument posed by the authors on the age issue is that, mopane worms harvesting is highly labour intensive and requires excessive amount of time and thus, not attractive to the younger generation. Also younger people often migrate outside their homes for educational and work purposes and thus are often not available during mopane worm harvesting seasons.

Due to the labour intensiveness of mopane worm harvesting, household size has been revealed to have a positive effect on mopane harvesting (Stack *et al.*, 2003). According to Stack *et al.*, (2003), the number of people in the household can influence the gains from mopane worm harvesting. For example, the more people there are in the households, the higher the quantities of mopane worm harvested, the higher the quantities harvested, the higher the sales and consumption of mopane worms.

Religion of a household head has been reported to have both positive and negative effects on household's participation in mopane worm harvesting. A study by Kozanayi and Frost (2002) on mopane worm marketing in Southern Zimbabwe reported a low participation of households in mopane worm activities around the Romwe study area. According to the study, households were not harvesting mopane worms due to the limited or narrow consumer base in the area. The area is occupied by households belonging to the Zionist church e.g. Zion Christian Church (ZCC) whose religious beliefs forbids the consumption of mopane worms. Stack *et al.*, (2003) also reported a low participation of mopane worm activities in the areas dominated by households belonging to the Zionist church. This shows a negative effect of the Zion religion on mopane

worm activities, however, the study showed other religions like Pentecostals and Catholics to have positive impact on mopane worm activities.

According to Stack *et al.*, (2003), mopane worm harvesting to some extent is affected by the level of education of the households head. For example, Lucas (2010) noted a negative relationship between education of a household head and mopane worm harvesting. The studies revealed that, highly educated household heads usually find better jobs and thus do not necessary depend much on mopane worm harvesting. Nevertheless, Stack *et al.*, (2003) suggested that a positive relationship between education of a household head and mopane worm activities, the study claimed that, educated members of harvesting households living in the mopane woodlands who are no longer dependent on mopane worm harvesting often tend to continue to invest in the other mopane worm activities. Thus the effect of education goes both positive and negative depending on the context of the household.

On households' income, Stack *et al.*, (2003) reported the quantity of mopane worm harvested to be higher for poorer households as compared to the better off or richer households the Mwenezi study area. An explanation given was that, poorer households harvest more mopane worms as a source of food and income through mopane worm sales due to poor income earning opportunities faced by poor households. Thus low households' income is associated with high mopane worm harvesting. However, in the Botswana area, the study found that, better off households hardly harvest mopane worms as a result of good income earning opportunities.

A study by Gondo *et al.*, (2010) on the sustainable use of mopane worms in Southern Africa found a positive link between households' expenditure and mopane worm activities. The study reported that, households harvest mopane worms for sales whereby the income from mopane

worm sales are used to supplement their household income. In some cases, households are known to barter mopane worms to their neighbours as to receive other household items they can't afford to buy e.g. food, clothes, utensils etc., which in turn reduces their households' expenditure on both food and non-food items. Also, some households harvest mopane worms to reduce their food expenditure i.e. mopane worms serves as relish for porridge or as snack, and thus households do not have to purchase other relish which could save them money on their food expenditure (Gondo *et al.*, 2010). Ghazoul (2006) added that, households harvest mopane worms usually for the purpose of commercialisation, therefore, the long distances to markets could affect the ability of mopane worm harvesters to transport their harvest to the markets for sale.

### **2.1.2 Mopane worm commercialisation**

In essence, mopane worm commercialization occurs when household production (harvesting) system shifts from producing mopane worms for subsistence to harvesting for the market. Lucas (2010) defined commercialisation as a deliberate action on the part of mopane worm harvesters, of their own free will or by means of coercion. The history of mopane worm commercialization has been around since the primitive Pedi people of the Limpopo Province discovered it (Ghazoul, 2006). Initially, the mopane worm used to be an important food source for the rural communities within the range of mopane woodland (Lucas, 2010). However, as time went on, the worm is now widely consumed in Southern Africa and gradually developed into an important trading commodity (Stack *et al.*, 2002). Ghazoul (2006) reported that, the mopane worm trade linkages stretch across neighbouring borders of South Africa into Botswana, Zambia and the Democratic Republic of Congo.

### **2.1.3 Factors affecting mopane worm commercialisation**

Mopane worm studies have identified households' socio-economic factors and characteristics that affect mopane worm commercialisation. As indicated above, households harvest mopane worms for subsistence and commercialisation thus, According to Stack *et al.*, (2003), households' socio-economic characteristics like age, gender and education level of a household head affects mopane worm commercialisation in ways similar to mopane worm harvesting. From the review above, it is evident that, mopane worm harvesters are mainly adult females and thus a positive relationship between mopane worm commercialisation, age and gender of the household head. As established by Stack *et al.*, (2003), highly educated household heads tend not to participate in mopane worm activities due to time limitations and thus a negative relationship between education level of a household head and mopane worm harvesting.

Lucas (2010) indicated harvesting experience as a factor that affects mopane worm commercialization. The study reported 90 percent of the harvesters commercializing mopane worms in the Tamasane and Kgagodi villages to be having at least twenty years of harvesting experience. Further, the study revealed that, 47 percent of the households with less than 5 years of harvesting experience harvested mopane worms for subsistence and not for commercial purposes.

Kozanayi and Frost (2002) reported a negative association between mopane worm consumption and commercialisation. The study revealed the frequency of consumption as a detrimental factor in reducing the quantity of mopane worms available for sale. Ghazoul (2006) added that, per capita consumption of mopane worms could improve the diet quality of households; however, an

increase in the quantity consumed per capita could be a barrier to households achieving good gains from mopane worm sales.

A study by the Southern Alliance for Indigenous Resources (SAFIRE) on mopane worms in Southern Africa reported a positive relationship between mopane worm commercialisation and the income gained from mopane worms (SAFIRE, 2013). The study SAFIRE (2013) reported more households to be commercializing mopane worms as a result of the high income associated with mopane worm trading. In this study, more than 50 percent of the harvesters commercialized their harvest and earned an average of about R1 000 from trading which is almost half of the households total average income earned per month.

A study by Makhado *et al.*, (2009) on the contribution of woodland products to rural livelihoods in the Giyani area of the Limpopo Province reported distance to markets as a barrier in mopane worm commercialisation. The study revealed mopane worm harvesters in Giyani region as the main supplier of mopane worms in the region, however, these harvesters are located in remote areas far from town centre's which makes them inaccessible at times. Coupled with the seasonal market supply patterns, Harvesters in Homu village in rural Giyani said that they sold limited quantities of mopane worms at a time, either to mopane worm collectors or by trekking to primary markets which negatively affect their sales (Makhado *et al.*, 2009). Senyolo *et al.*, (2009)'s study on the patterns of access and utilization of output markets by emerging farmers in South Africa; using factor analysis model found a negative relationship between commercialisation of small holder output and distance to the market.

One of the necessary outcomes of mopane worm harvesting and commercialization is that the mopane worm market system becomes increasingly integrated into the wider economy.

Integration occurs mostly on the output side of mopane worm production where harvesters only have to sell their mopane worms in a market (Ghazoul, 2006). This integration into the wider economy means that harvesters shift their goals from self-sufficiency towards profit and income generation (Lucas, 2010). Increasing incomes and economic growth through mopane worm harvesting and commercialization implies that households will have access to new and more assets to contribute to food security (Stack *et al.*, 2003). How exactly these conditions determine food security is a crucial part of this thesis and will be discussed next.

## **2.2 Concept and definitions of food security**

Early definitions of food security defined food security as the availability of adequate supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices at all times (Sen, 1981; Chavas, 2002; Lamb, 2011). However, recently, food security has been defined in a broader framework which encompasses individual behaviour in the face of uncertainty, irreversibility, and binding constraints on choice (Lamb, 2011). According to Barrett (2002), economics has come to view food security through a framework of uncertainty, risk and vulnerability. Introducing concepts of risk and uncertainty more accurately portrays food security as a time variant probability of falling below a certain threshold of consumption to satisfy the physical and social requirements of food intake. As such, risk and uncertainty help to account for the fact that food security status is likely to vary over the course of the lifetime of the individual and is subject to random shocks to health and the immediate environment. With reference to food security vulnerability, the dynamic nature of food security is implied when individuals are vulnerable to experiencing food insecurity in the future (Barrett, 2002). Frankenberger *et al.*, (1992) defined vulnerability as a combination of exposure to risk and access to coping mechanisms to manage that risk. By combining the effects of risk,

uncertainty and vulnerability to food security, Hoddinot (1999) defined food security as a jointly determined product of household food access, individual food access and biological utilization based upon individual health activities. The study further noted that, the ultimate focus of food security is the nutritional status of the individual household member and the risk of that adequate status not being achieved or becoming undermined. A household's or individual's ability or inability to manage this risk describes the household's vulnerability to food security i.e. the ability to ensure adequate food security hinges on the ability to identify vulnerable households. Thus, vulnerability refers to the full range of factors that place people at risk of becoming food insecure and can either be a chronic (occurring over extended period of time) or transitory (within short period of time) phenomenon (Frankenberger *et al.*, 1992).

Nevertheless, the Food and Agriculture Organisation developed two workable definitions of food security that is commonly used and widely accepted today. These definitions are as follows: (1) "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life", and (2) "Food security is the access by all people at all times to enough food for an active, healthy life" (FAO, 2002, pp 1).

### **2.2.1 Dimensions of food security**

From the FAO definition of food security above, the World Health Organisation (WHO, 2012) identified food availability, food access, and food as the three physical (physical flow of food) dimensions of food security and food stability as the fourth temporal dimension and defined the four dimensions as: (1) Food availability is defined as the food that is physically present because it has been grown, manufactured, or transported there. For example, food is available because it

can be found in markets, produced on local farm land or home gardens, or because it arrives as part of food aid, etc. This is food that is visible and in the area: (2) Food access includes the ability of a household to acquire enough food to support life, health, and activity. Food access also is a function of the physical environment, social environment and political environment which determine how effectively households are able to utilize their resources to meet their food security objectives, and (3) Food Utilization is defined as the proper use of food in the household which includes households employing proper food processing and storage techniques, adequate knowledge of nutrition and child care techniques exist and are applied, and the existence of adequate health and sanitation services.

Food stability deals with the time frame for which food security is been considered; this can either be chronic (over extended periods of time) or transitory (short period of time) (Barrett, 2002). The first three dimensions of food security (availability, access and utilization) follow a certain hierarchy (Holben, 2002). For example, food availability is necessary but not sufficient for access and access is necessary but not sufficient for food utilization (Holben, 2002). Therefore, adequate and appropriate utilization is an input for achieving adequate access for all (health, sound nutrition and other human capital effects) through some sort of a feedback loop; whilst, food access is needed for sustainable food availability (Holben, 2002). The dependency or interaction of food availability on access and utilization and vice versa, over time can result in different conditions going from acute food insecurity (famine), through seasonal discontinuities (lean seasons), to assured access and utilization for all individuals (Hoddinot, 1999). The fourth dimension of stability refers to the risks people are exposed to, those are crucial to understanding food insecurity (Du Toit *et al.*, 2011). Therefore, in order to assess or measure the contribution mopane worm's activities to the household's food security in the Limpopo Province, discussions



on the nature of food security (i.e. the state of food security including all dimensions) within the study area and how mopane worm activities may impact on it. The following section discusses food security status in South Africa.

### 2.3 The state of food security in South Africa

South Africa is faced with a wide variety of challenges for ensuring food security. These challenges arise from issues at national level to issues at household level. At the national level, South Africa is a food secure nation that produces enough staple foods and with the capacity to import food if needed to meet the basic nutritional requirements of its population (Du Toit *et al.*, 2011). However, at the household level, many families have an insufficient and unsteady food supply which has been a challenge for many years (Du Toit *et al.*, 2011).

Recently, four national food insecurity surveys conducted in South Africa utilizing the Community Childhood Hunger Identification Project (CCHIP) as an indicator for hunger (food insecurity) showed high levels of food insecurity in the country (see Table 1).

**Table 1: Scores for food security, risk of hunger and experience of hunger (food insecurity) using data from four national surveys, South Africa 2012**

Variable	NFCS 1999 (n = 2 735) (%)	NFCS 2005 (n = 2 413) (%)	SASAS 2008 (n = 1 150) (%)	SANHANES 2012 (n = 6 306) (%)
Food security	25.0	19.8	48.0	45.6
At risk of hunger	23.0	27.9	25.0	28.3
Experiencing hunger	52.3	52.0	25.9	26.0

**Note:** *National Food Consumption Survey (NFCS); South African Social Attitudes Survey (SASAS); South African National Health and Nutrition Examination Survey (SANHANES)*  
*Source: Shisana et al., (2013).*

Table 1 shows that, the proportion of food insecure households decreased from 52.3 percent 1999 in to about 26 percent in 2008. This is almost about half reduction in the number of

households experiencing food insecurity. However, households at the risk of being food insecure increased about 3 percent between 1999 and 2005, decreased in 2008 (25 percent) and increased about 3 percent again in 2012 (28.3 percent). This shows a variation in the levels of households at risk of being food insecure. A possible explanation to the rise and fall in the number of households at risk of been food insecure could be due to the nature of food insecurity in South Africa. At a national level, food insecurity has been attributed to lack of exchange entitlements (Sakyi, 2012). Sen (1981) defined the concept of an exchange entitlement to demonstrate the empirical reality of the persistence of food insecurity despite the fact that food is available in a given locality. Essentially, when prices of food rise to a certain extent that individuals can no longer afford to purchase food, the exchange entitlement to food erodes off, not the absence of food, and thus the erosion of the exchange entitlement is the cause of the food insecurity experienced by the individual (Sen, 1981).

The SANHANES results in Table 1 shows that household's food security has been maintained above 45 percent; however, this still doesn't show any improvement in the national household's food security from the 2008 percentage (48 percent). Labadarios *et al.*, (2011) defined improved household food security as a situation whereby food is more available and accessible to a larger part of the population. This implies more households in South Africa still lack food accessibility and availability. A possible explanation may be due to South Africa's inability to provide safety nets for food shortage disasters (Van der Merwe, 2011). Van der Merwe (2011) explained that, the challenge is to create economic conditions that would favour poor households that suffer from food insecurity. However, South Africa's long history of factors such as income inequalities, lack of access to finance, poor communication infrastructure, poor education and

poor skills development facilities makes it rather difficult for favourable households' economic conditions to be created (Du Toit *et al.*, 2011).

Unfavourable household's economic conditions have been linked to low earning potentials within South African households and high food prices (Van der Merwe, 2011). Coupled with the challenge of high food prices, rural to urban migration plays a significant role in South African household food insecurity (Van der Merwe, 2011). With more than half of South Africa's population (about 61.7 percent) currently residing in urban areas, one of the biggest social and developmental challenge is to ensure food security for all people in urban areas. Since urban household's food access is highly dependent on the household's income availability and urban food availability is largely determined by food supply to cities, the complex distribution chains of South Africa's food supply systems often result to higher food prices in urban areas. Consequently, urban poor households become more vulnerable to food insecurity due to their limited form of income (Van der Merwe, 2011).

By province, Western Cape and Gauteng had the lowest reported number of households experiencing hunger at 16.4 and 19.2 percent respectively. However, the Eastern Cape Province and Limpopo had the highest percentage of households experiencing hunger above 30 percent (see Table 2).

**Table 2: Food insecurity within the Provinces of South Africa**

Province	Food secure	At risk of hunger	Experienced hunger
Western Cape	57.9	25.6	16.4
Eastern Cape	31.4	32.4	36.2
Northern Cape	56.5	22.8	20.7
Free State	39.3	31.9	28.8
KwaZulu-Natal	37.3	34.4	28.3
North West	40.4	30.0	29.5
Gauteng	56.0	24.8	19.2
Mpumalanga	55.0	15.5	29.5
Limpopo	41.9	27.3	30.8
Total	45.6	28.3	26.0

**Note:** *Hunger is a proxy for food insecurity*

Source: *Shisana et al., (2013).*

Similar results on high food insecurity have been reported across the Limpopo Province. For instance, Sakyi (2012) reported 53 percent of the households in the Limpopo Province as severely food insecure. De Cock *et al.*, (2013) also reported severe food insecurity rate at 53.1 percent in the Limpopo Province. Hart (2009) reported that, about 49 percent of Limpopo Province residents experienced hunger during the twelve-month period of his study and this was as a result of their inability to purchase sufficient food at various times.

### **2.3.1 Factors affecting food insecurity**

A majority of the food security studies in the Limpopo Province have attributed the high levels of food insecurity in the Province to households' social and economic factors like gender, age and education of the household head, as well as the household's income and the number of people in the household (household size). For instance, a study by Sakyi (2012) on household food security (access) and its determinants across selected rural households in the Limpopo

Province using the HFIAS module in an Ordinary Least Squares model (OLS) on a sample of 600 households found socio-economic factors such as age, gender and education of household head, household size and households income to affect food insecurity in the Limpopo Province. By gender of the households head, the study found a negative relationship between gender and household food security whereby the study reported female-headed households to be more food insecure compare to their male counterparts.

On age of a household head, Sakyi (2012) study found a positive relationship between the age and households food security. This finding was similar to a recent study by De Cock *et al.*, (2013). De Cock *et al.*, (2013) study on food security in the rural areas of the Limpopo Province using Multivariate analysis on a sample of 599 households reported a negative relationship between young household head and food security in the household.

Moreover, Sakyi (2012) study reported a positive relationship between the education level of a household head measured in years and household food security. The study emphasized that, education in different forms such as formal or non-formal as well as skills training are very useful as it tends to develop the capacity of people to enhance food security by increasing the households earning potential which subsequently improves household's food access. This positive impact of education emphasised by Sakyi (2012) was confirmed by a previous study on the state of food insecurity in the world by the Food and Agriculture Organisation (FAO) in 2009; that reported a strong positive correlation between education, empowerment and food security. In addition to the FAO (2009) report, Baiyegunhi and Makwangudze, (2013) study on home gardening and food security status of HIV/AIDS affected households in Mpophomeni, KwaZulu-Natal Province of South Africa; using a linear regression model on 33 households also reported a negative relationship between the years of education of a household head and food

insecurity whereby household heads with more years of education were more likely to be food secure.

However, households' size has been reported by several authors to have an inverse relationship with household's food security. For example, De Cock *et al.*, (2013) reported severe forms of food insecurity to be associated with large household size. Baiyegunhi and Makwangudze, (2013) also reported a negative relationship between household size and food security. Furthermore, a study by Bashir *et al.*, (2012) study on food security in the Punjab region of Pakistan; using a logistic regression model also reported a negative relationship between households size and households food security,

On household's income, Sakyi (2012) argued that, since food security relies heavily on having more access to food and having access to food depends on an individual's purchasing power to command enough food that is needed, households having access to social grants and other government social assistance tends to have better household income which can improve their food security (access) status. Thus the study reported a positive relationship between household's income and food security which confirmed by the findings of Baiyegunhi and Makwangudze, (2013) who reported a positive relationship between households income and food security.

The majority of studies have emphasized on the important role that markets play in the provision of food for most rural households in the Limpopo Province. For example, a study by Baiphethi and Jacobs (2009) on the contribution of subsistence farming to food security in the Limpopo Province found food purchases from markets making up about 90 percent household food sources. Sakyi (2012) study also reported a high dependence on markets as a household's food source and emphasised a negative relation between households inability to access market and

food security. However, a study by Makhura (2001) on overcoming transaction costs barriers to market participation of smallholder farmers in the Limpopo Province viewed rural markets not only as a source of food but rather as a source of income whereby an increase in the distance from households to markets was seen as detrimental to households food security as it increased transaction cost of trading.

## **2.4 Mopane worms and households food security**

The Food and Agriculture Organisation (FAO, 2008) suggested that, the best way to examine how an agricultural product influences food security is to examine it through the dimensions of availability, access, and utilization. Thus, the contribution of mopane worm activities to household's food security will be examined through the stated dimensions of food security. However, it must be noted that, while it is helpful to demarcate how mopane worm activity influences food security through these dimensions, each linkage cannot be neatly placed in one category. Oftentimes linkages may belong to two categories, by blending the separation between each dimension. For example income is a financial resource that affects household food access. However, as previously explained the type of income also affects how a household utilizes it to obtain food.

For instance, in terms of availability, mopane worm harvesting can increase the physical quantity of food available for consumption. Mopane worm harvesting and commercialisation can also affect food access in a number of ways. Commercializing harvested mopane worms potentially provides a resource through income that can be used to obtain food. Mopane worms have been documented to have easy cooking methods and saturated with high levels of protein and essential nutrients and thus consuming mopane worms could improve household's food utilization

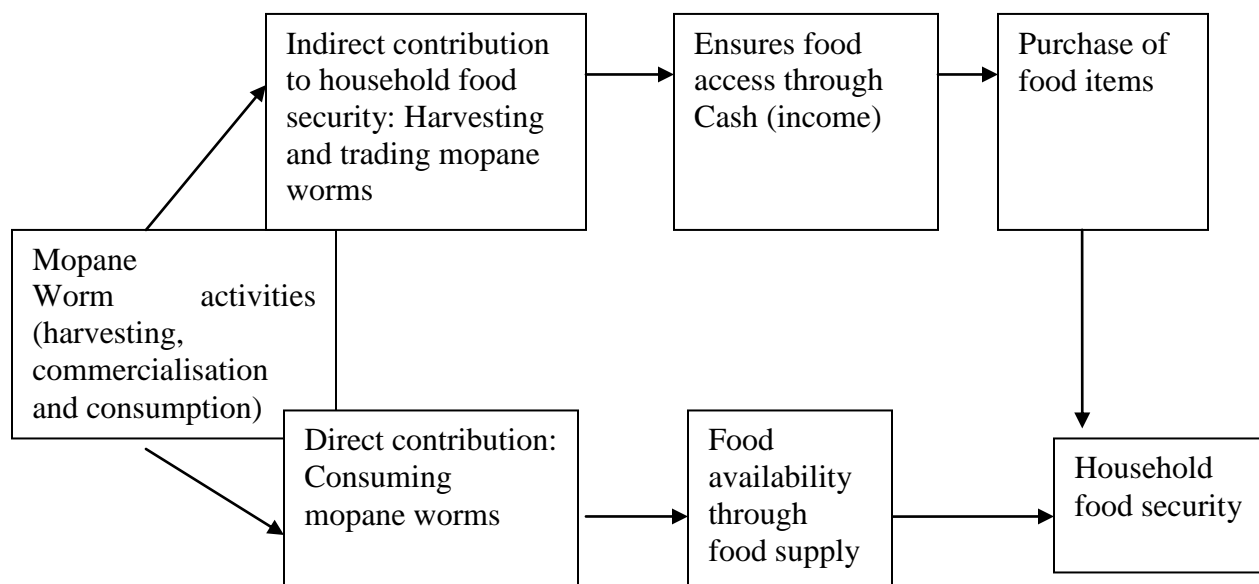
(Ghazoul, 2006). These examples reveal that, not only are there many varied linkages between food security and mopane worm activities, but also that the direction and magnitude of these linkages can greatly differ with the circumstances of the household. This suggests that there can be no definitive or generic conclusion on how mopane worms relates to food security. However, empirical studies on mopane worm activities have revealed a complex relationship complicated by the many linkages and decision making points (Stack *et al.*, 2003; Makhado *et al.*, 2009; Ghazoul, 2006).

The pathway from food consumption to food security status is relatively simple and direct. However, when mopane worm activities decisions are included, the relationship between mopane worm's production and food security become far more complex and context specific. Thus it is vital to have a clear understanding of mopane worm activities and food security relationship and how it is mediated by family and community factors to accurately model and analyse observed outcomes of each situation. In this study, this relationship is examined as the potential contribution of mopane worm activities to household food security and is discussed below.

## **2.5 Contribution of mopane worms to household food security**

The relationship between household's participation in mopane worm activities, household food security and welfare has conceptually been illustrated by several studies (Stack *et al.*, 2003; Lucas, 2007; Konzanayi and Frost, 2002; Ghazoul 2006). This concept is shown in figure1 below.





**Figure 1: Conceptual framework of the contribution of mopane worms to food security**

*Source: Stack et al., (2013)*

According to this conceptual framework (Figure 1) the importance of mopane worms to household food security will be explained in terms of a household's decision to participate in mopane worm's activities (harvesting, commercialization and consumption) and how each individual activity may contribute to household food security. Applying this framework, contribution to food security will be divided into two categories (indirect and direct) for discussions.

### **2.5.1 Indirect contribution of mopane worms to household food security**

This refers mostly to the practice of selling or battering of mopane worms to generate income which is then used by the household to purchase food. Mphuchane *et al.*, (2000) pointed out that, the harvesting of mopane worms is usually business that provides seasonal employment to many rural people in South Africa. Stack *et al.*, (2003) reported that income from mopane worm

harvesting may contribute up to a quarter of total annual cash income for rural households. For example, outbreak of mopane worms occurs in low-income areas, these insects are available in the period of food shortage, particularly at the beginning of the rainy season when livestock is lean, new crops have just been sown and the stocks of stored produce from the previous crop season become limited. In South Africa, first outbreak of mopane worms occurs during November and December period; the worms will be ready for sale around January to February period. The second outbreak of mopane worms occur from April to June depending on rainfall availability (Konzanayi and Frost, 2002). Consequently, local markets are flooded with mopane worms packed in plastic bags and sold as food articles during the planting season (Konzanayi and Frost, 2002). Mopane worms thus acts as a safety net for households off seasonal shortages of income and food. Similarly, in case of natural disasters (floods, droughts, epidemics of human diseases), mopane worms can serve as a safety net buffering households against drought, or other food or income shocks.

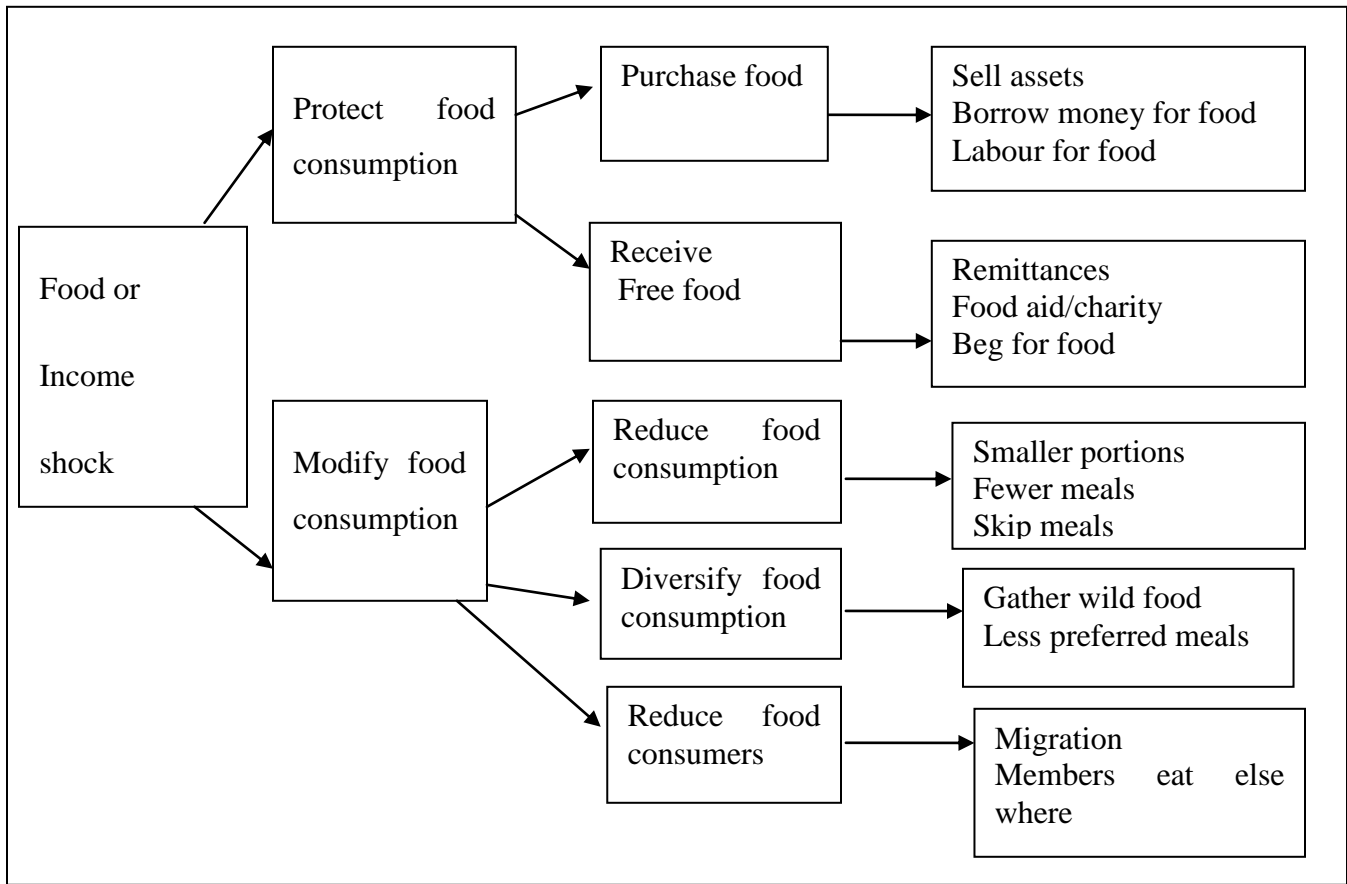
### **2.5.2 Direct contribution of mopane worms to food security**

A study carried out in Zimbabwe by Campbell *et al.*, (1987) found that mopane worms were gathered mostly during the times of famine. Thus, mopane worms provided important coping strategies for rural dwellers during times of food shortages. As a food source, mopane worms are highly nutritious as they contain as much or more protein as meat or fish (Rebe, 1999). Moruakgomo (1996) added that, based on the nutrition content of mopane worms, vulnerable groups like pregnant women, lactating mothers and children in rural communities, mopane worm can serve as a valuable source of nutrition for them. A combined study on mopane worms nutrients by Dreyer and Wehmeyer (1982) concluded that, mopane worms are high in proteins and thus the consumption of mopane worms can supplement the predominantly cereal diet of

rural households with many of the protective nutrients. Mopane worms are a good source of essential polyunsaturated fatty acid, iron, zinc and vitamin A. According to the Food and Agriculture Organization (FAO, 2012), About 2 billion people are deficient in zinc, 1 billion have iron-deficiency anaemia, and vitamin A deficiency affects some 250 million people, mainly young children and pregnant women in developing countries. The study reported the mopane worm is a very important insect and its consumption to provide the necessary nutrients to reduce illness and malnutrition in rural areas (FAO, 2012). Thus, mopane worms as a source of food does not only increase household food availability, but also provide the essential nutrients necessary for ensuring a healthy and nutritious lifestyle.

## **2.6 Household coping strategies to improve food security**

Devereux (2001) defined coping strategies as a response to adverse events or shocks i.e. all the strategically selected acts that individuals and households in a poor socio-economic position use to restrict their expense or earn some extra income to enable them to pay for the basic necessities (food, clothing, shelter) and not fall too far below their society's level of welfare. Maxwell (1996) added that, the strategies pursued by households often differ in several aspects, that is, within the household and between households. However, depending on degree of wealth among households, different coping behaviours are adopted by households at different poverty levels. Nevertheless, majority of the studies on coping strategies adopted by households recognize that households facing food shortages are forced to trade off short term consumption needs against longer term economic viability (Devereux, 2001; Davies, 1993). These trade-offs can be illustrated as a decision tree (see Figure 2) where households have to split between protecting and modifying food consumption to cope with food shortages. Protecting food consumption deals either with strategies to purchase or receive food from other sources.



**Figure 2: A categorisation of coping strategies used by households**

Source: *Devereaux (2001)*.

### 2.6.1 Strategies to protect food consumption

According to Davies (1993), coping strategies to protect food consumption are often termed as risk management strategies (income soothing) whereby households adopt ways diversify increase their household's income earning potentials. Depending on the economic welfare of the households, strategies adopted to diversify household's income may have some unintended erosive responses which can undermine the household's livelihood. For example, some households may choose to sell off productive assets to purchase food (protect their food consumption) which could be detrimental to the survival of the household should there be during extended periods of food shortages (see Figure 2). According to Ivers and Cullen (2011), selling

households assets to acquire food is one of the more erosive coping strategies to manage food insecurity risk; although it provides households with disposable income to purchase food, it has a higher long term cost effect on the future viability of the household. According to Devereux (1993), coping strategies with the least or minimum long term effect (e.g. drawing down savings or calling on remittance) are usually popular and is often adopted first by households, e.g. borrowing money from relatives or friends is less erosive and provides the household with the ability to survive the food shortage. For instance, a study by Mjonono *et al.*, (2007) on household food insecurity coping strategies in the Kwazulu Natal Province reported 52.5 percent of households in Embo region in KwaZulu Natal to be borrowing money from stokvels (rotating savings and credit associations) and about 34 percent from their relatives to protect their food consumption. The study also reported high number of households depending on charity, food aid and other financial assistance to receive free food.

### **2.6.2 Strategies to modify food consumption**

Households may also choose to modify their food consumption by reducing/modifying food or reduce the number of consumers (see Figure 2). These strategies could be less erosive as they ensure sustainable survival of the household through the risk period. However, depending on the duration of the risk (food shortage period), some households may choose to migrate out of the village in search of food. This is often signs of severe food insecurity among households (Devereux, 2001). Most households in the Mopani district of the Limpopo Province are often faced with crises of food and income shortages that threaten their security in terms of food availability. Also, households experiencing moderate to severe forms of food insecurity often tends to cut down on the quantity and quality of food consumed by reducing portion sizes, skipping meals or eating less preferred foods. According to Devereux (1993), the choice of

strategy adopted by households gives an indication of the severity of food insecurity within the households. Coates *et al.*, (2007) added that, when majority of households adopt strategies to reduce the quantity and quality of consumption, it is a sign that the households are faced with moderate to severe forms of food insecurity. Adekoya (2009) reported that, in time of crisis, most households may choose to diversify or modify their consumption habits to ensure food is available in the household. In the mopane district, due to lack of financial resources, households diversify their consumption by eating food that are less preferred and less expensive, and modifies their consumption either by reducing the number of dependant in the family, limiting the size of an individual's portion or completely skipping whole meals. However, Lucas (2010) argued that, though mopane worms are seasonal, when in season, they are available and easily accessible, and thus household's food modification does not result to a complete skip of meals.

## **2.7 Conclusion**

This chapter has reviewed relevant literature of household food security measurements vis-a-vis the analysis of changes resulting from history of Southern African insect consumption. The chapter concluded by highlighting the benefits derived from mopane worms' consumption. The next chapter describes the methodology used in this study.

## **CHAPTER 3**

### **METHODOLOGY**

#### **3.0 Introduction**

The previous chapter reviewed local and international literature relevant to this study. This chapter describes the research methodology used to collect data and to analyse variables that were considered to determine households' participation in mopane worm harvesting, in the Limpopo Province of South Africa. The chapter provides a brief description of the study area, sources of information used, sampling technique, and data collection method. The way the survey data were analysed is also presented in this chapter.

#### **3.1 Study area**

The study was conducted in four villages of the Mopani district of the Limpopo Province. There are five local municipalities within Mopani District. These are Ba-Phalaborwa, Greater Giyani, Greater Tzaneen, Maruleng and Greater Letaba. The predominant languages in the district are Northern Sotho and Tsonga. The district area is characterized by contrasts such as varied topography, population densities (low in the south, relatively dense in the north-east), prolific vegetates in the south (timber) and sparse in the north (bushveld) (Mopani District Municipality, 2012).

Around the Greater Giyani municipality area: the north eastern parts of the district (see Figure 2), majority of the villages fall within the mopane woodland (Mopani District Municipality, 2012). Households from these villages attain majority of their food consumption from Household food production and Non-Timber Forest Products (NTFP) (D'Hase and Vermeulen, 2011). According to (Makhado *et al.*, 2009) households in these areas often participate in mopane worm

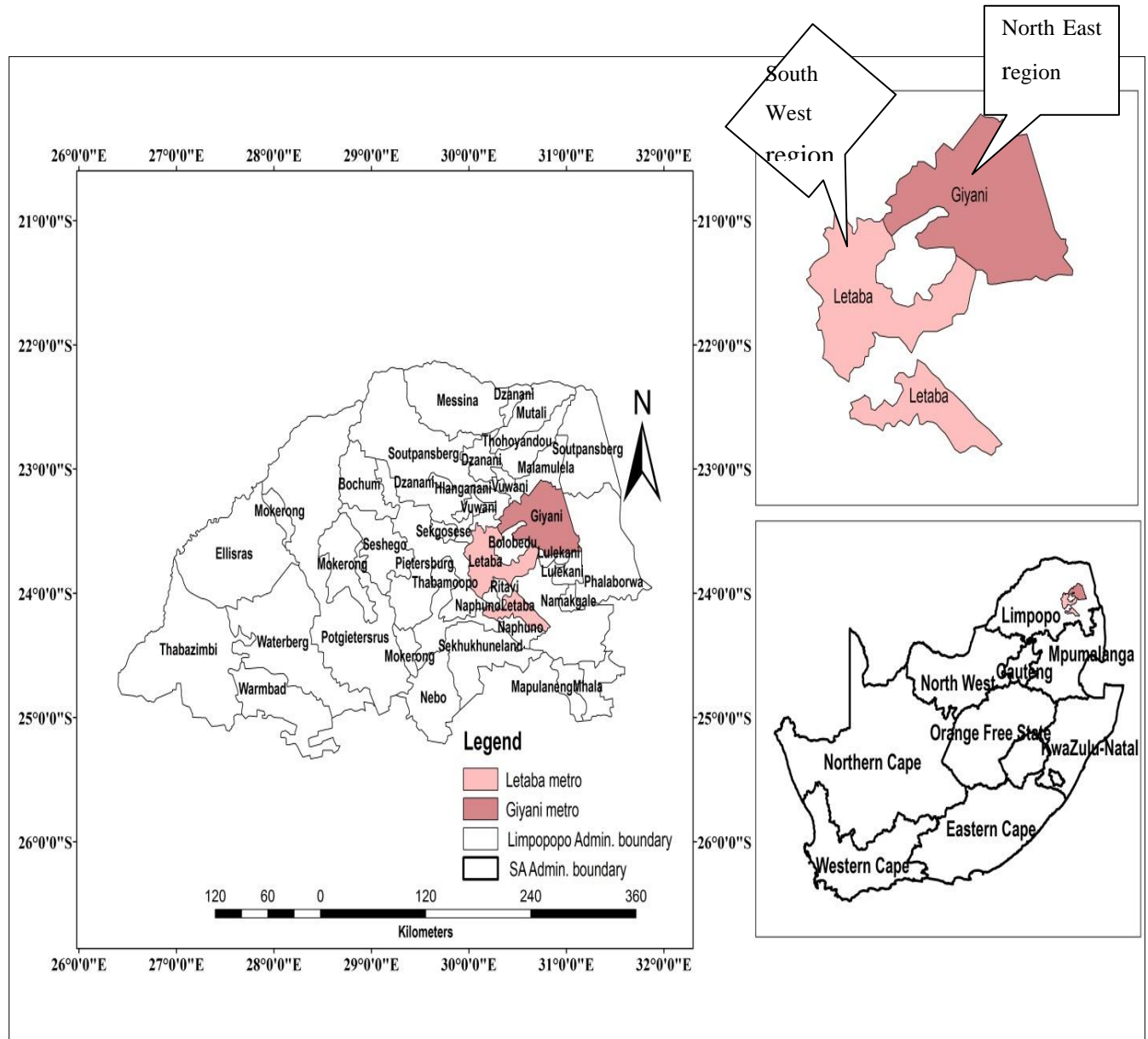
activities as a source of food and livelihood. Malepane (2012) added that, one would find stacks of bags of mopane worms ready for buyers within these villages. In terms of economic growth and livelihood, all of the four villages were faced with socio-economic factors such as geographical location (distance to markets), shortage of skills, poor infrastructure, climatic conditions and diseases (HIV and malaria), which impacts negatively on their livelihoods (Limpopo-DLGH, 2007). Food insecurity has been very prominent in these villages with almost all the households living in rural areas and unemployed (Limpopo-DLGH, 2007). According to D'Hase and Vermeulen (2011), Mopani district is one of the districts with the highest food insecure households with about 63 percent households being food insecure which has been attributed to low income earning opportunities, high illiteracy rate and high dependency ratio,

A study by Makhado *et al.*, (2009) on the utilization of mopane trees in rural South Africa reported that, in villages within the Greater Giyani municipality; men, women and children harvest mopane worms for household use and also as a supplement to their household income. The study further added that, within the periods, December-January and April-May, mopane worm activities seems to be the major contributor to household economy by providing households with food as well as access to other household items through the income generated through sales.

However, in areas within the South Western parts of the district (see Figure 3), household's participation in mopane worm activities are limited due to the scarcity of mopane trees around the areas (Limpopo-DLGH, 2007). These areas mostly fall within the Greater Letaba municipality. This municipality falls outside the mopane woodland and therefore most of the mopane worm activities within this area are limited to household's consumption. However, compared to households within the Greater Giyani region, the frequency of participation of



households in mopane worm activities is relatively low and almost insignificant (Malepane, 2012). Households within these areas rarely harvest mopane worms but rather trade and consume.



**Figure 3: Map of Mopani district showing the Greater Giyani and Greater Letaba Municipalities**

**Source:** Field survey (2013).

### **3.2 Sampling technique**

A stratified random sampling technique was used in the study. The purpose of the stratified random sample was to reduce the potential for human and selection bias in the selection of households included in the sample (Imbens and Lancaster, 1996). The first stage of the sampling was to identify the areas within the municipality with abundant mopane worms and areas with depleted mopane worms. A local nature Local nature conservation official and an extension officer from the Department of Agriculture and Forestry in the Limpopo Province were asked to select two grouped mopane woodland depleted villages within the Province. Greater Giyani, Ba-Phalaborwa and Maruleng municipalities were classified as areas with abundance of mopane worms and mopane worm activities. Greater Tzaneen and Greater Letaba municipality forms the mopane worm's depleted areas. Greater Letaba and greater Giyani municipalities were randomly selected for the study. The next step was to identify the villages for data collection. In the greater Letaba municipality, Sekgopo and Mamaila were randomly selected in the Greater Letaba municipality whilst Homu and Mapayeni villages were selected for the Greater Giyani municipality. Given the more economically homogeneous nature of these villages, stratification was done according to mopane worm activities occurring in the villages. According to the local nature conservationist from the Department of Agriculture and Forestry in the Limpopo Province, most households in Homu and Mapayeni villages' harvest (collect) mopane worms for household consumption and trading (sales), whilst most households in Sekgopo and Mamaila are non-harvesters. Thus the two strata were defined as households harvesting mopane worms for consumption and sales (group 1) and households not harvesting mopane worms (group 2). With the help of the extension officer, a list of households involved in mopane worms' activities was given from which 10 percent from each village were selected to give the total number of

respondents. Thus the total population of the villages were not necessary considered for the sampling size calculation. To ensure that only harvesters or non harvesters were used in the thesis, a snowball technique whereby harvesters led the researcher to other harvesters was then adopted in each stratum to identify the respondents. The study interviewed 120 households in total with 60 from each group.

### **3.3 Methods of data collection**

The main method used in the collection of the data was household interviews. The information was collected through a structured questionnaire and administered on individual head of households. The developed questionnaire comprised of several parts, amongst others, geographic, demographic, income and consumption expenditures, household food security status, coping strategies adopted by households to combat food insecurity and mopane worm harvesting and commercialization.

### **3.4 Data analysis techniques**

Descriptive analysis including frequencies, means, standard deviations were calculated to describe the household's socio-economic characteristics.

#### **3.4.1 Binary logistic regression households' participation model**

The first objective of the study was to determine households' socio-economic factors affecting participation in mopane worm harvesting. To achieve this objective, a binary logistic regression was used to identify the socio-economic factor that affects households' participation in mopane worm activities. That is, to see if a household will be mopane worm harvesters or non-harvesters given their socio-economic characteristics. The binary logistic regression model was chosen because it directly estimates the probability of an event occurring for more than one independent

variable using a maximum likelihood estimation rather than the least squares estimation used in traditional multiple regression (Hailu and Nigatu, 2007). The maximum likelihood approach tries to find estimates of parameters that make the data actually observed most likely representative of the probabilities i.e. the values of the estimated parameters are adjusted iteratively until the maximum likelihood value for the estimated parameters is obtained. Therefore to specify the regression model predicting the logit, that is, the natural log of the odds of a respondent been a harvester or not given their households socio-economic characteristics was specified as:

$$Y = \text{Logit}(P_i) = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_1 + \dots \beta_K X_K \quad (1)$$

where,  $Y$  = the probability of the  $i$ th household to be a harvester (harvester =1 or non-harvester = 0)

$\beta_0$  = constant term

$\beta_{1-k}$  = the coefficients of the predictor variables

$X_{1-k}$  = a combination of  $k$  discrete and continuous predictor variables that affect the outcome variable  $Y$ .

In the logistic analysis, the measure of effect of variables on the dependent variable was measured by the odds ratio which is specified as:

$$\frac{P_i}{1-P_i} = \exp^{(\beta_0 + \beta_1 X_1)} \quad (2)$$

where,  $\frac{P_i}{1-P_i}$  = the probability of the outcome  $Y$  occurring

$\exp^{(\beta_0 + \beta_i X_i)}$  = the exponent of the coefficients of the predictor variables  $X_{1-k}$ .

The Odds ratio in a logistic regression is the effect of a one unit of change in  $X$  in the predicted odds ratio with the other variables in the model held constant. For interpretation of variables in this study, the Odds ratio was used to interpret the logistic regression coefficients. According to Hosmer and Lemeshow (2000), in an experimental intervention an odds ratio equal to 1 means the effect of the variable on the outcome is identical to the effect the variable would have on the control; an odds ratio less than 1 reduces the chance of having the event and an odds ratio greater than 1 increases the chance of having the event. The smallest value an odds ratio can take is zero. The predictor variables in the model together with their a priori expectations are presented in Table 3.

**Table 3: Definition of variables included in the logistic model**

Variable	Code	Definition and measurement	Expected signs
Gender	Gender	Dummy variable measured as 1 if male, 0 otherwise	-
Age	Age	Age in years of the household head	+
Education	Edu	Education of the household head in years	-
Household size	HHsize	Number of people in the household	+
Religion (Pentecostal)	ReligiPent	Dummy variable measure as 1 if household head is of Pentecostal religion	+
Religion (ZCC)	ReligiZCC	Dummy variable measure as 1 if household head is of ZCC religion	-
Religion (Catholics)	ReligiCath	Dummy variable measure as 1 if household head is of catholic religion	+
Household's income	HHinc	Household's monthly income from formal income, social grants, small businesses and remittance.	-
Non-food expenditure	NFex	Households expenditure on non-food items	+
Food expenditure	Fex	Households expenditure on food items	+
Distance market	Dmkt	Distance to the nearest market to buy and sell	-

**Source:** *Based on a priori expectations*

### **3.4.2. The mopane worm commercialisation model**

The second objective was to identify socio-economic factors that determine the rate of commercialisation of mopane worms within harvesting households. This objective dealt with the level/rate of participation in the output market for harvesters and thus was addressed in two stages. In the first stage, the level of mopane worm commercialisation was calculated then an Ordinary least square model was used to identify the factors that determine mopane worm commercialisation.

Von Braun *et al.*, (1994) and Govereh *et al.*, (1999) suggested the degree of participation in the output market as a conventional way to measure commercialization and thus measured commercialisation using the quantity of the product sold against the quantity of the product produced. Nevertheless, Govereh *et al.*, (1999) added that, there would always be some amount of output that even a basic subsistence farmer would sale in the market so as to buy basic essential goods and services and thus, the ratio of marketed output up to a certain minimum level cannot be taken as a measure of commercialization unless some threshold or cut off value is specified beyond which commercialisation begins. Following Von Braun *et al.*, (1994) and Govereh *et al.*, (1999) methodology, this study calculated the rate of commercialization (RoC) in percentages as:

$$RoC = \left( \frac{Q_{MWS}}{Q_{MHS}} \right) * 100 \quad (3)$$

where,  $RoC$  = the rate of commercialisation (%)

$Q_{MWS}$  = the quantity of mopane worms sold (kg)

$Q_{MWH}$  = the quantity of mopane worms harvested (kg).

However, to identify the rate at which commercialisation begins in the sample, the study followed the methodology of Ruhangawebare (2010) who used a 50 percent threshold level to identify the factors affecting the level of commercialisation among cattle keepers in Uganda. Thus RoC values below this threshold means households purposely harvest mopane worms for subsistence. Further, an Ordinary Least Square model (OLS) was applied using the values above the threshold level as dependent variables against households' socio-economic factors which

have been hypothesized to affect mopane worm commercialisation. The commercialisation model is specified as:

$$RoC = \lambda_0 + \lambda_1 X_1 + \dots + \lambda_K X_K + U \quad (4)$$

where,  $RoC$  = the rate of commercialisation (%)

$X$  = the household factors that affect the level of total crop sales

$\lambda_0$  and  $\lambda_{1-k}$  = estimable parameters

$U$  = the error term

To access the properties of the estimated coefficients from the OLS regression ( $\lambda_{k-1}$ ), the following assumptions under the OLS were adhered to in the study. The assumptions were: 1. correct model specification, this assumption was assessed using the F test. According to Gujarati (2004) a statistically significant F test could be an indication of a correctly specified model.  $R^2$  was also used to assess the model fit. Assumption of normality in residuals was assessed using a normal P-P plot. A normal P-P plot shows linearity among variables in the model. Assumption of co linearity was assessed using the Variance Inflation Factor (VIF). Gujarati (2004) note,  $VIF < 10$  indicates less or no degree of multicollinearity. The assumption of homoskedaticity was assessed using the Ramsey Test. The Ramsey Test analysed homoskedaticity by regressing the squared predicted values from the regression on the dependent variable again. A statistical significant result would imply hetroskedaticity and thus variables would need to be transformed. Should all these assumptions be met then the coefficients will be Best Linear Uncorrelated and efficient (BLUE). The independent variables used in the commercialisation model are presented in Table 4.



**Table 4: Definition of variables included in the commercialisation model**

Variable	Code	Definition and measurement	Expected signs
Gender	Gender	Dummy variable measured as 1 if male, 0 otherwise	-
Age	HHAge	Age in years of the household head	+
Education	Edu	Education of the household head in years	+
Distance to harvesting site	Dharvsite	Nearest distance to where mopane worms are harvested	-
Harvesting experience	Hexper	Number of years you have been harvesting mopane worms	+
Frequency of consumption	Frecon	Number of days mopane worms are consumed in a week	-
Mopane worm income	Mwi	Income from mopane worm trading	+
Per capita consumption	PPC	Quantity of mopane worms consumed per head	-
Distance market	Dmkt	Distance to the nearest market to buy and sell	-

**Source:** *Based on a priori expectations*

### **3.4.3 Mopane worms and household food security model**

The third objective was to examine the impact of mopane worms on the food security status of the households in the Limpopo Province. This objective was addressed in two stages following the methodology of Baiyegunhi and Makwangudze (2013). In the first stage, households food security status was analysed using the Households food insecurity access scale (HFIAS) and then an ordinary least square analysis was conducted using the HFIAS scores as a dependent variable with other household socio-economic factors and mopane worm activities variables in an

ordinary least square regression analysis to determine the determinants of household food insecurity.

The HFIAS is based on the eighteen-question U.S. Household Food Security Survey Module (US HFSSM) and is based on the idea that the experience of food security (access) causes predictable reactions and responses that can be captured and quantified through a survey. The survey is a set of 9 occurrence questions combined with a set of 9 frequency questions (Baiyegunhi and Makwangudze, 2013 and Coates *et al.*, 2007). These are questions related to the occurrence and frequency of occurrence of conditions that are associated with the experience of food insecurity occurring during the previous month (30 days) (Baiyegunhi and Makwangudze, 2013). According to Coates *et al.*, (2007), the question of occurrence of household food insecurity is related to three main domains of food insecurity which are: anxiety, uncertainty about household food supply, insufficient quality of food which includes a variety and preferences of the type of food in particular and insufficient food intake and its physical consequences.

During the administration of the HFAIS module, the household head or the person responsible for the households food consumption decisions will be asked if the situation described in each question has occurred in the last 30 days. When the answer is in the affirmative (occurrence), they were asked to indicate the frequency in which such an event occurred: never (0 times in the past month), rarely (1-2 times in the past month), sometimes (3 to 10 times in the past month), or often (more than 10 times in the past month). The score ranges from 0-27 and is calculated as:

$$\text{HFIAS Score (0-27)} = \text{Sum frequency code (Q1 + Q2 + Q3 + Q4 + Q5 + Q6 + Q7 + Q8 + Q9)}$$

where, Q1-Q9 = the questions of the HFIAS module (see appendix 1).

The higher the score the more food insecure the household is. The HFIAS scores were categorized into four categories of household's food security status: food-secure, mildly, moderately and severely food-insecure based on the categorization scheme recommended by the HFIAS Indicator Guide as shown on Figure 11(see appendix 1) to give the Household Food Insecurity Access Prevalence (HFIAP). According to the HFIAS categorization scheme, a food secure household experiences none of the food insecurity (access) conditions, or just experienced worry, but rarely; a mildly food insecure household worries about not having enough food 'sometimes' or 'often', and /or 'rarely' ate a monotonous diet or less preferred food. However, the household does not cut back on quantity nor experience any of the three most severe conditions i.e. going for a whole day without eating, going to bed hungry or running out of food ; A moderately food insecure household is faces similar experience to the mildly food insecure household however, a moderately food insecure household cut back on quantity by reducing size of meals or number of meals 'rarely' or 'sometimes ; a severe food insecure household experiences similar conditions to that of a moderate food insecure household, however, severe food insecure households experiences any of the three most severe conditions even as frequently or 'rarely'.

To estimate the relationship between household food security and mopane worm activities, two proxy variables representing mopane worm activities (mopane worm income and frequency of consumption) were hypothesized to measure the direct and indirect contribution of mopane worms to household food security. Indirect contribution of mopane worms refers mostly to the practice of selling or battering of mopane worms to generate income which is then used by the household to purchase food (Stack *et al.*, 2003). Thus, mopane worm income in this case was used as a proxy for measuring the indirect effects of mopane worm activities on household food

security. Mopane worm income was calculated as the income from trading mopane worms plus the value of mopane worms retained by the household for consumption. The frequency of mopane worm consumption was used as a proxy measuring the direct contribution of mopane worm activities. Using an ordinary least square model, the food security model is specified as:

$$FS = \alpha_0 + \alpha_1 \sum X_k + \alpha_2 X_2 + \alpha_3 X_3 + U \quad (5)$$

where,  $FS$  = HFIAS score

$X_k$  = the households socio-economic variables

$X_2$  = mopane worm income

$X_3$  = the frequency of consumption.

Thus, if the OLS model generates significant relationships on any of the two proxy variables, the study will conclude that mopane worm activities contribute significantly to household food security. The variables used in the ordinary least square analysis to estimate the determinants of household food insecurity were presented in Table 5 together with their expected signs.

**Table 5: Definition of variables included in the food security model**

Variable	Code	Definition and measurement	Expected signs
Gender	gender	Dummy 1 if male and 0 otherwise	-
Age	HHage	Age of the household head in years	-
Education	Edu	years of education of household head	-
Household size	HHsize	Number of people in the household	+
Household income	HHInc	households income excluding mopane worm income	-
Food expenditure	Fex	households expenditure on food	+
Distance to market	Dmkt	Distance to market to buy/sell	+
Mopane worm income	Mwi	Income from mopane worm trading	-
Frequency of consumption	Frecon	Number of days mopane worms are consumed	-

**Source:** *Based on a priori expectations*

### 3.5 Conclusion

This chapter highlighted the methodology adopted by the study to determine the households' socio-economic factors affecting participation in mopane worm harvesting, to identify household's socio-economic characteristics that determine the rate of commercialisation of mopane worms within harvesting households and to examine the impact of mopane worms in the food security status of the households in the Limpopo Province. The next chapter however presents the study's result, discussions and analysis whereby the three hypotheses postulated in chapter 1 will be tested with the results of the analyses presented in the next chapters.

## **CHAPTER 4**

### **FACTORS AFFECTING HOUSEHOLDS' PARTICIPATION IN MOPANE WORM ACTIVITIES**

#### **4.0 Introduction**

The previous chapter highlighted the methodology used in this study. This chapter presents the result and discussions of the socio-economic factors affecting mopane worm harvesting and commercialisation. The household's socio-economic characteristics are presented in section 4.1. These include, gender, religion, age, household size, education level, total expenditure, distance to markets households income and household involvement in mopane worm activities. The factors affecting commercialisation of mopane worms are also presented in this chapter.

#### **4.1 Households' socio-economic characteristics**

Table 6 shows the socio-economic characteristics of the mopane harvesters and non-harvesters in the Limpopo Province. The descriptive analysis reveals that 60 percent of harvesters are female-headed households while 80 percent of the non-harvesters are male-headed households. This implies that male-headed households are hardly harvesters of mopane worms. The average age of harvesters is about 45 years while non-harvesters have an average age of about 37 years. This implies that the younger generations do not engage in harvesting mopane worms. On average, harvesters household consists of 7 people while non-harvesters consist of 5 people. In addition, harvesters are less educated than non-harvesters. This is revealed by the level of education; whereby on average, harvesters' have 9 years of education while non-harvesters have 13 years.

**Table 6: Households' socio-economic characteristics**

	Harvesters	Non- harvesters	Total
	(n=60)	(n=60)	(n=120)
Variable	Percent	Percent	Percent
Gender of the household head			
Male	40.0	80.0	60.0
Female	60.0	20.0	40.0
Religion			
Pentecostal	55.0	68.3	61.7
ZCC	6.7	1.7	4.2
Catholics	26.7	26.7	26.7
Other (unspecified)	11.7	3.3	7.5
	Mean	Mean	Mean
Age	45.2 (11.4)	37.3 (12.9)	41.3 (12.7)
Household size	6.5 (1.5)	5.2 (1.5)	5.8 (1.6)
Education (Years)	9.4 (6.4)	13 (6.3)	11.2 (6.6)
Food expenditure (Rand/month)	678.7 (229.6)	725.8 (311.8)	702.2 (273.7)
Non-food expenditure (Rand/month)	375.1 (269.3)	376.9 (236.3)	375.9 (252.3)
Households income (Rand/month)	1985.5 (962.8)	1525.5 (1160.2)	1755.4 (1086.4)
Distance to market to buy/sell (km)	3.1 (2.7)	2.76 (1.658)	2.9 (2.2)

**Note:** Standard deviations are in parenthesis

**Source:** Field survey (2013)

Household's expenditure comprised of food and non-food expenditure. An average household in the study area spends about R702 on food items and about R376 on non-food items. On average, a household receives an income of about R 1 755 per month and households had to travel an average of about 3 km to reach a market. According to Stack *et al.*, (2003), household's involvement in mopane worm activities is often affected by households' religious affiliation. 61.7 percent of respondents were Pentecostals, 26.7 percent were Catholics and 4.2 percent were of the Zion Christian Church (ZCC).

#### **4.1.2 Socio-economic factors affecting household's participation in mopane worm activities**

A binary logistic regression analysis was employed to analyse the socio-economic factors affecting household's participation in mopane worm activities. The result of the regression estimates are presented in Table 7. The participation variable was a dummy variable coded as 1 for harvesters and 0 for non-harvesters. That is, to predict the probability that a respondent would be a mopane worm harvester. The estimates of the probabilities were computed and explained in terms of the odds-ratios (OR). A test of the full model versus a model with intercept only is statistically significant,  $X^2(11, N = 120) = 87.51, p < .001$  and the overall success rate of the model prediction is 71 percent. The values of Cox and Snell and Nagelkerke  $R^2$  were 0.347 and 0.462, respectively. The Hosmer and Lemeshow (H-L) test was insignificant ( $p > 0.325$ ), suggesting that the null hypothesis of a good model fit to the data was accepted. Results from the Receiver Operating Characteristic (ROC) curve (see appendix 1) showed the area under the curve to be 0.853 with 95 percent confidence interval (0.78, 92) and significantly different from 0.5 since p-value is 0.000. This means the logistic regression classified the respondents significantly better than by chance.



**Table 7: Results of the logistic regression model for factors affecting participation.**

	Coefficient	Standard error	Prob	Odd ratios
Gender (Male)	-1.07**	0.52	0.04	0.35
Age (Years)	0.33**	0.02	0.01	1.39
Education (Years)	-0.04	0.04	0.33	0.96
Household size (Number)	0.57***	0.18	0.00	1.77
Religion(Pentecostals)	1.63*	0.94	0.08	5.11
Religion (ZCC)	-0.87**	0.84	0.04	0.42
Religion (Catholics)	-1.25	0.88	0.15	0.29
Household's income (Rand)	0.45**	0.16	0.01	1.57
Non-food expenditure (Rand)	0.00	0.00	0.31	1.00
Food expenditure (Rand)	-1.16**	0.72	0.01	0.31
Distance to market (km)	0.09	0.11	0.42	1.10
Constant	-5.87	2.59	0.02	0.00
Model prediction success (percentage)		77.5		
Log-likelihood ratio test statistics		114.1		
Cox & Snell R <sup>2</sup>		0.353		
Nagelkerke R <sup>2</sup>		0.471		
H-L model significance test results (df = 8)		12.855 (p-value = 0.217)		

**Note:** \*\*\*, \*\*, and \* denotes statistical significance at the 1, 5, 10 percent level respectively  
: Religion dummy (no religion) was omitted as a reference category for the religion variable.

The coefficient of gender (male) which contrasts ‘male headed households’ and ‘female headed households’ is statistically significant and negatively related to mopane worms harvesting. The odds ratio for gender (0.35) indicates that holding all other variables constant, a male headed household is 0.35 times less likely to harvest mopane worms compared with their female counterparts. This result is expected and consistent with the findings of Stack *et al.*, (2003) and Lucas (2010); who reported a high dominance of female households in mopane worm harvesting.

A possible explanation could be due to the fact that, mopane worm harvesting has been traditionally considered as a women's task and thus men generally shy away or may be due to the fact that, rural men find other income generating activities outside their homes.

The coefficient of age of the household head is statistically significant and positively related to mopane worms harvesting. The odd ratio of 1.39 on age implies that, for each year increase in the age of the household head, the household is 1.39 times more likely to harvest mopane worms. This result is expected and consistent with the findings of Stack *et al.*, (2003) who reported harvesters to be mainly female adults aged above 33 years. In this study, the average age for harvesters was about 45 years. This shows that mopane harvesters are likely to be old. One possible explanation could be due to the fact that, mopane worms during and after harvesting requires enormous amount of time and labour which has traditionally been done by older women in the household.

The coefficient of household size measured by the number of people in the household is statistically significant and positively related to mopane worms harvesting. The odd ratio for household size is 1.77. This indicates that, with a unit increase in household size, the respondent is about 2 times more likely to be a mopane worm harvester. One possible explanation for this positive relationship could be due to labour provision. According to Stack *et al.*, (2003), households comprising of 7 or more members often harvest their own mopane worms for consumption as labour distribution between harvesting and processing of the mopane worms are shared among them.

The coefficient on the religion dummy (Pentecostal) which contrast Pentecostal religion with 'no religion' category is statistically significant and positively related to mopane worm harvesting.

This odds ratio of 5.11 on the coefficient means that; for every household belonging to a Pentecostal religion is about 5 times more likely to harvest mopane worms than a household with no religion. However, the coefficient on the religion dummy (ZCC) which contrast 'ZCC' with 'no religion' (omitted reference category) is statistically significant and negatively related to mopane worm harvesting. The odds ratio for religion (ZCC) dummy is 0.42. This implies that, households belonging to ZCC religion are 0.42 times less likely to harvest mopane worms than households with no religion. A possible explanation could be due to the effect of ZCC religion attitude towards mopane worms. These results are consistent with the findings of Kozanayi and Frost (2002) and Stack *et al.*, (2003). A possible explanation for the positive and negative relationship of religion could be attributed to the religious beliefs of both religions. The ZCC religion believe mopane worms as unclean and unfit for human consumption and thus forbid its members from participation in any mopane worm activity whilst the Pentecostals believe mopane worms as sanctified for consumption.

The coefficient of household income measured in Rand is statistically significant and positively related to mopane worm harvesting. The odds ratio of 1.57 on households income implies that, for every Rand increase in respondent's household income increases the probability of the respondent household been a harvester. A logical explanation could be due to the economic incentives realized from mopane worm harvesting. Stack *et al.*, (2003) reported a widespread harvesting of mopane worms and suggested that, the utilization of mopane worms is not limited to the poorest households but is an activity undertaken by all social classes.

The coefficient of households food expenditure measured in Rand is statistically significant and negatively related with mopane worm harvesting. The odds ratio of 0.31 on food expenditure implies that, for every Rand increase in the household's food expenditure decreases mopane

worm harvesting. This result was unexpected as one would expect households to harvest more mopane worms when their food expenditure increases. Contrary to this result, other studies have found a positive relationship between mopane worms harvesting and household food expenditure. For example, Gondo *et al.*, (2010) reported that, households harvesting mopane worms earn extra income which supplements their household's expenditures on food, health and education; also mopane worms have been documented to have high nutritional contents which could substitute other household's food requirements and reduce food expenditure. However, outbreak of mopane worms can be unreliable and unpredictable during mopane worm harvesting seasons. According to Stack *et al.*, (2003), mopane worms outbreaks depends on the rainfall level in the area and therefore, during drought and dry conditions, mopane worms outbreaks can be unreliable and unpredictable which can greatly affect mopane worm harvesting. In instances like this, households will now have to buy the food items that mopane worms were substituting with their income instead of the extra cash that could have been earned from mopane worm harvesting. Thus food expenditure will be rising as harvesting is decreasing which could explain the negative relationship.

#### **4.2 Mopane worm harvesting, and commercialization**

The analysis of mopane worm harvesting and commercialisation are presented in Table 8. The Table shows that, on average, a household harvests about 17 kg of mopane worms and sells about 11kg of it. The household travels about 3 km to reach mopane worm harvesting site and the average harvesting experience in years was about 8 years. On average, a household member consumes about 1.3 kg of mopane worms at least 3 days in a week.

Mopane worm income is made up of sales from mopane worms trading and the value of mopane worms retained for consumption. On average, a harvester receives about R955/month from mopane worm. Mopane worms commercialisation calculated as the percentage of quantity sold over quantity harvested (quantity sold/quantity harvested\*100) had an average of about 53 percent indicating a high rate of commercialisation in the study area.

**Table 8: Mopane worm commercialisation variables**

<b>Variable</b>	<b>Mean</b>
Quantity harvested (kg)	17.3 (13.3)
Quantity sold form harvesting (kg)	11.2 (11.1)
Mopane worm income(Rand/month)	954.9 (673.6)
Distance to harvesting site (km)	2.9 (1.9)
Harvesting experience (years)	7.8 (3.3)
Per capita consumption (kg/head)	1.2 (1.1)
Frequency of consumption (days)	3.6 (1.5)
Rate of commercialization (%)	53.0 (33.1)

**Note:** Standard deviation in parenthesis

**Source:** *Field survey (2013)*

#### **4.2.1 Determinants of mopane worm commercialisation among harvesters**

The results of the OLS regression estimating the factors affecting mopane worm commercialisation are presented in Table 9. The result shows that about 51.3 percent ( $R^2=0.513$ ) of the variation in the dependent variable rate of commercialisation, was explained by the variation in the explanatory variables incorporated in the model. The overall significance and fitness of the model was checked with the F value; accordingly, a statistically significant F value (2.9) indicated that the independent variables reliably predict the dependent variable. Regression diagnostic procedures were carried out to test for multicollinearity, normality of residuals and

autocorrelation. The results showed no evidence of multicollinearity as the Variance Inflation Factors (VIF) were ( $<10$ ), P-P plot showed normality in residuals (see appendix 1) and the coefficient on the Ramsey Test showed homoscedasticity (a statistically insignificant relationship  $P$  value =0.27) and thus the parameter estimates were efficient and consistent.

**Table 9: Estimated coefficients of the linear regression model for commercialisation**

	Coefficient	Standard Error	t statistics	Prob
(Constant)	75.85	14.77	5.14	0.00
Gender (Male)	-1.03**	0.41	-2.53	0.02
Age (Years)	0.03	0.17	0.20	0.85
Education (Years)	0.04	0.30	0.13	0.90
Distance to harvesting site (km)	1.39	1.07	1.30	0.21
Harvesting experience (Years)	0.97*	0.52	1.87	0.07
Frequency of consumption (Days)	-2.76**	1.15	-2.40	0.02
Mopane worm income (Rand)	0.01**	0.00	3.02	0.01
Per capita consumption (kg/head)	-10.39***	2.86	-3.64	0.00
Distance to market to buy/sell	-1.41**	0.50	-2.85	0.01
R <sup>2</sup>		0.513		
F		2.9**		

**Note:** \*\*\*, \*\*, and \* denote statistical significance at the 1, 5 and 10 percent levels, respectively.

The results of the ordinary least square regression estimates shows that the coefficient of gender (male) is statistically significant and negatively related to mopane worm commercialisation. The 1.03 coefficient on gender (male) implies that, male headed reduces commercialisation by 1.03 percent compared to their female counterparts. This result confirms the negative relationship between mopane worm activities and gender of a household head. A logical reasoning to this fact could be due to amount of the time spent by women in mopane worm activities. Mopane worm

activities have been known to require excessive amount of time from the point of harvest till point of consumption. Due to this, mopane worm harvesting is often dominated by elderly women and children in the household.

The coefficient of harvesting experience is statistically significant and positively related to mopane worms' commercialisation. A coefficient of 0.97 implies that, for each year increase in the number of years the household harvest mopane worms increases commercialisation by 0.97 percent. This result is consistent with the findings of Lucas (2010), that households experienced in mopane worm harvesting adopt better and efficient harvesting techniques which allows them to harvest more mopane worms for sales and households consumption within a short period of time. This indicates that, the more experienced a household is in harvesting mopane worms, the less likely they will harvest for subsistence only.

The coefficients of the frequency of consumption (numbers of day's mopane worms are consumed in a week) and per capita consumption measured in kg consumed per head were both statistically significant and negatively related to commercialisation. The coefficient of 2.76 for frequency of consumption and 10.39 for per capita consumption implies that, for every day increase in the number of days a household consumes mopane worms and every kg increase in the quantity of mopane worms consumed per head in the household decreases mopane worm commercialisation. This finding is in line with Kozanayi and Frost (2002) who reported that, depending on the quantity of mopane worms harvested by a household, should the quantity consumed out off the harvest increase, the household stands to lose out on the amount of extra cash they could have earned from selling their stock. A logical explanation could be that, an increase in the frequency of consumption together with an increase in per capita consumption increases the actual quantity of mopane worms consumed. In theory, an increase in quantity

consumed reduces the quantity available for commercialisation which could explain the negative relationship.

The coefficient of mopane worm income measured in Rand is statistically significant and positively related to commercialisation. The coefficient of 0.01 on mopane worm income indicates that, for every Rand increase in households income increases commercialisation by 0.01. This result is in line with the findings of the Southern Alliance for Indigenous Resources (SAFIRE, 2013). SAFIRE (2013) concluded on mopane worm income as the most important reason for households participating in mopane worm commercialisation as it provides a platform for rural households to survive harsh economic situations. This could explain the associated positive relationship.

The coefficient of distance to market (Market access) measured in kilometers was statistically significant and negatively related to commercialisation. The coefficient of 1.41 implies that, for every kilometer increase in distance to market decreases commercialisation. This result was expected and consistent with literature on market access and commercialisation. For example, Senyolo *et al.*, (2009) and Makhado *et al.*, (2009) reported lack of market access as one of main reasons why households do not commercialize their surplus produce. A possible explanation could be that, households further away from markets or households with no market access tends to keep their produce for consumption rather than for sale. This shows the important role market access plays in commercialisation which could subsequently explain the negative relationship.



### **4.3 Conclusion**

This chapter has presented the results, discussions and analysis in view of making recommendation in the next chapter. The next chapter deals with the contribution of mopane worms to household food security.

## **CHAPTER 5**

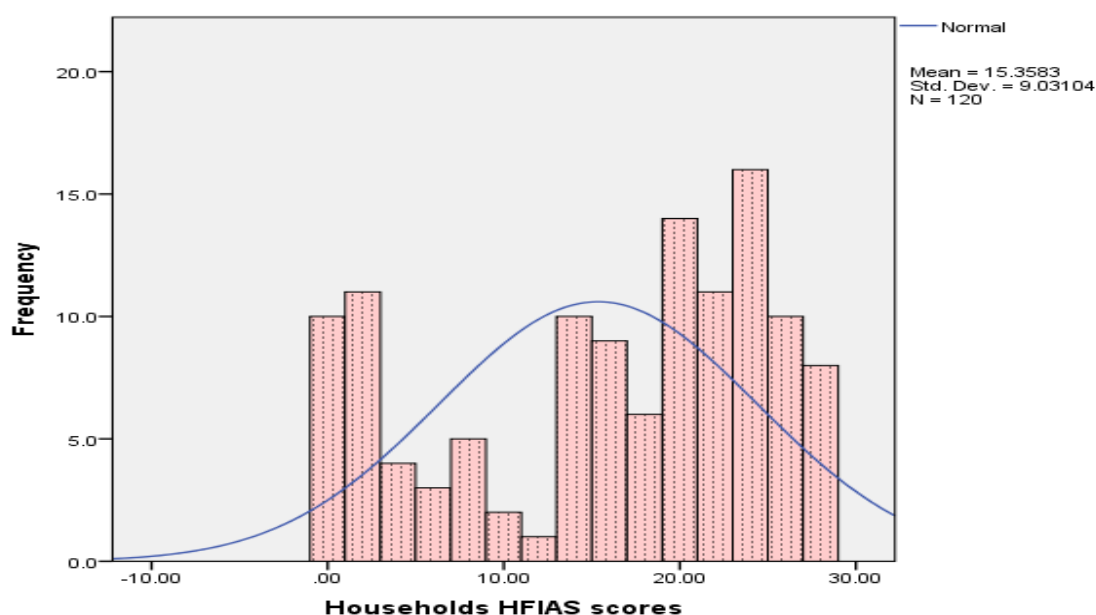
### **CONTRIBUTION OF MOPANE WORMS TO HOUSEHOLD FOOD SECURITY**

#### **5.0 Introduction**

The previous chapter describes the factors affecting households' participation in mopane worm activities (harvesting, commercialisation and consumption). This chapter examines the impact of mopane worm on the food security status of the households in the Limpopo Province. The Household Food Insecurity Access Scale (HFIAS) was used to determine household food security status.

#### **5.1 The incidence of household food insecurity**

The description of household food security status based on the household food insecurity access scale (HFIAS) developed by the Food and Nutrition Technical Assistance (FANTA) project of USAID is presented in Figure 3. The HFIAS scores ranged from 0 to 27 with an average score of about 15 (SD = 9.1). A score of 15 is an indication that, an average household in the study area is moderately food insecure. Implying that, on average, a sampled household worries about not having enough food 'sometimes' or 'often', and /or 'rarely' ate a monotonous diet or less preferred food and cut back on quantity by reducing size of meals or number of meals 'rarely' or 'sometimes' (Coates *et al.*, 2007).



**Figure 3:** The frequency distribution of households HFIAS Scores  
**Source:** Field survey (2013)

The HFIAS scale provided a continuous measure of household food insecurity (scores) which was categorized into four levels of household food insecurity prevalence [food secure (0-1), mild food insecure (2-14), moderate food insecure (15-23) and severe food insecure (24-27)] (Coates, 2007). Thus the prevalence of food insecurity in the study area is presented in Table 10.

**Table 10:** Food security status of households in the Limpopo Province

	Harvesters (n=60)	Non harvesters (n=60)	Total (n=120)
Food security status	%	%	%
Food secure	20.0	11.7	15.8
Mildly food insecure	16.7	28.3	22.5
Moderately food insecure	35.0	41.7	38.3
Severely food insecure	28.3	18.3	23.3
Total	100	100	100

**Source:** Field survey (2013)

The HFIAS results presented in Table 10 revealed that, overall, about 16 percent of the households are food secure, about 22 percent mildly food insecure, about 38 percent moderately food insecure and 23.3 percent severely food insecure. This result is consistent with other food security studies in the Limpopo Province. Sakyi (2012) and De Cock *et al.*, (2013) reported that a higher proportion of households in the Mopani District are experiencing food insecurity. This implies that, a high proportion of the households are experiencing food insecurity. The results from this study indicate the persistence and increasing trend of the problem in the study area. One possible explanation could be due to the low income earning opportunities available in the study area. In South Africa, household's income has been identified as the principal determinant of household food security (Kirsten *et al.*, 2003 cited in Baiyegunhi and Makwangudze, 2013), diversified income base can help reduce household vulnerability to food insecurity. However, in this study, household's income was highly dependent on government's social assistance income and mopane worm income. However, both income sources have been found to be unsustainable and could have implications on the future household food security. For example, Sakyi (2012) indicated that, while social grants serve as a major source of income for many households, it must as well be a major source of concern when the issue of sustainability of such grants come into question especially when the net tax in South Africa covers only a few.

## **5.2 Factors influencing household food insecurity**

To analyse factors influencing food insecurity status of households, socioeconomic characteristics of households and two proxy variables measuring the direct and indirect contribution of mopane worms to food security were regressed on the HFIAS scores using an Ordinary least square model. Estimates from the regression are presented in Table 11. The result of the model gave an R-square value of 0.664 implying a 66.4 percent of the variation in

household food security status was explained by the independent variables included in the model. Regression diagnostic procedures were carried out to test for multicollinearity, normality of residuals and autocorrelation. The results showed no evidence of multicollinearity as the Variance Inflation Factors (VIF) were ( $<10$ ), P-P ) plot showed normality in residuals (see appendix 1) and the coefficient of the Ramsey Test (0.08) showed a statistically insignificant relationship with p value of 0.982 (homoskedasticity); thus the parameter estimates were efficient and consistent.

**Table 11: Determinants of household food insecurity**

Variable	coefficient	Standard error	t statistic	Prob
(Constant)	14.52	4.70	3.09	0.00
Gender (Male)	0.30	1.45	0.21	0.84
Age (Years)	-0.02 <sup>*</sup>	0.01	-1.81	0.08
Education (Years)	-0.01 <sup>***</sup>	0.00	-10.62	0.00
Household size (number)	1.45 <sup>***</sup>	0.48	3.04	0.00
Households income (Rand)	-0.90 <sup>**</sup>	0.34	-2.64	0.01
Households expenditure on food (Rand)	0.31	0.64	0.49	0.63
Distance to market (km)	0.97 <sup>**</sup>	0.35	2.76	0.01
Mopane worm income (Rand)	-1.34 <sup>**</sup>	0.46	-2.92	0.01
Frequency of consumption (Days)	-0.92 <sup>**</sup>	0.38	-2.41	0.02
R <sup>2</sup>	0.66			
F statistic	8.55 <sup>***</sup>			
Ramsey Test	0.08(p-value = 0.85)			

**Note:** <sup>\*\*\*</sup>, <sup>\*\*</sup>, and <sup>\*</sup> denote statistical significance at the 1, 5 and 10 percent levels, respectively

The results of the ordinary least square regression estimates show that the coefficient of age measured by years is statistically significant and negatively related to food insecurity. The age coefficient of 0.02 indicates that, for every year increase in the age of household head decreases

household food insecurity by 0.02 point on the HFIAS score. This means, as the age of the household head increases by each, the more likely the household will be food secure. This result was expected and in line with the findings of Sakyi (2012) who found a negative relationship between age of the household head and household food insecurity. This negative sign on the coefficient of age could be explained by the prominence of the social assistance programmes for the elderly persons in South Africa. During the survey, majority of the households reported to be receiving old age pension grant in a form of social assistance from the government. The social assistance pension grant programme in South Africa has been concerned with reducing poverty among the elder people and their households, insurance against adverse effects, as well to ensure the facilitation of investments in human capital which subsequently improves households' food security. Therefore, with households' access to pension grant, an increase in the age of a household head will reduce food insecurity.

The coefficient of education of household head measured in the number of years of schooling is statistically significant and negatively related to household food insecurity. As indicated in Table 11, the 0.01 coefficient on education of the household head indicates that, for every year increase in the number of years a household head spends in school result in a 0.01 decrease in the household food insecurity. This result was expected and consistent with other food security studies. For example, The FAO (2009) and Baiyegunhi and Makwangudze (2013) both found positive relationships between education of the household head in years and household food security. In this study the average household head had at least 11 years of schooling. Implying that, the average household head in the study area had at least some basic form of education to develop their food security capacity which could explain the negative relationship between years of education and household food insecurity.

The coefficient of household size is statistically significant and positively related to household food insecurity. The 1.45 coefficient on household's size implies that, for every additional member added to the household size increases households food insecurity by 1.45. This implies that, households with large family size are more likely to be food insecure compared to those with smaller family size. This positive relationship is expected and in line with other studies. According to Sakyi (2012), where households are more dependent on social assistance from government any increase in the number of people in the household increase the chances food insecurity in the household. A possible explanation to this could be the fact that, an additional increase in the number of people in the household would increase the demand of food in the household. In this study, the highest contributor to household's income was government's social assistance which contributed about 37 percent of household's income. This shows a high dependence of households in the sample area on social assistance as a source of livelihood. Moreover, an average household had at least 6 members, therefore, for any additional member to be added on would increase the likelihood of the household been food insecure.

The coefficient of household income measured in Rand is statistically significant and negatively related to household food insecurity. The 0.90 coefficient on household's income indicates that for every Rand increase in income decreases households food insecurity by 0.90. The negative sign on the coefficient of income is expected and consistent with other studies. For example, Baiyegunhi and Makwangudze (2013) reported a negative relationship between households income and food insecurity. One possible explanation for this relationship could be due to the fact that, increasing incomes of households translates to higher purchasing power to buy food thereby ensuring that the household have access to food.

The coefficient on distance to market measured in kilometers was statistically significant and positively related to food insecurity. The 0.97 coefficient on distance to market implies that, for every 1 kilometer increase in distance to market increases households food insecurity. This is expected and consistent with that of Makhura (2001) and Senyolo *et al.*, (2009). Long distances to markets or remote areas increase transaction costs which in effect reduce the prices offered for a given good on sale. Sellers are forced to be price takers, and they lose more in value than what they gain, which subsequently affects their incomes and reduces food access; thus increases vulnerability to food insecurity. In this study, majority of the sampled households receives their incomes from trading mopane worms; therefore, an increase in distance to markets will increase the cost of reaching the markets which in turn increases the transaction cost of trading mopane worms. A higher transaction cost could discourage households from buying or selling from markets which will subsequently lead to market inaccessibility.

The coefficients of mopane worm income and frequency of mopane worm consumption (the proxy indicators measuring the direct and indirect contribution of mopane worms to food security) are both statistically significant and negatively related to food insecurity. The coefficients on mopane worm income (1.34) and frequency of consumption (0.92) indicates that, for every Rand increase in mopane worm income and every extra day increase the number of days mopane worms are consumed decreases households food insecurity by 1.34 and 0.92 respectively. This result is expected and consistent with other mopane worm studies. According to Styles (1994), mopane worm income serves as an additional source to household income which provides a safety net to households in times of dire need for cash for food and other household activities. De foliart (1995) added that, mopane worms consumption for lactating mothers can have a significant positive influence on their diet which could lead to improved food



secure status. This implies that, increasing mopane worm income accompanied by an increase in the frequency of consumption increases the likelihood of household been food secure. A possible explanation could be due to the fact that, increasing the frequency of consumption directly increases food consumption whilst an increase in mopane worm income increases household's income which improves food access.

### **5.3 Coping strategies to combat households' food insecurity**

According to Devereux 1993, when households are faced with severe food shortages (food insecurity), they make strategic decisions to bridge their consumption gap. Therefore, to understand how households participating in mopane worm activities cope with severe food shortages, the Devereux categorization of households coping strategies (Devereux, 1993) were used to classified the strategies adopted by households in the study area. These strategies include; strategies to protect food consumption and strategies to reduce food consumption.

#### **5.3.1 Strategies to protect food consumption**

These are strategies adopted by the household to immediately maximize consumption in times of food scarcity. The household's decision is either to purchase food or find ways to receive free food. Results under both choices are presented in Table 12. From Table 12, it is evident that borrowing money for food was the most common strategy adopted by the households. About 57 percent of the households borrowed money to buy food during food shortages which is in line with the findings of Mjonono *et al.*, (2007) who reported a high number of households adopting this strategy. Selling mopane worm for cash was the second highest strategy adopted by households with 48.3 percent of households adopting this strategy. This result finding is not surprising, as earlier discussions have outlined mopane worm commercialisation to be high in the

study area. Also, this result emphasises the importance of mopane worms to household food access in the study area. Despite, the high inter annual variability in mopane worm production which makes mopane worm income a bit unreliable, most households prefer to trade in mopane worms as a source of income to purchase food than to use households' savings or selling off households' assets. Nevertheless, about 23 percent of the households in the study area adopted this strategy, which could be an indication of extreme vulnerability of household's to food insecurity.

**Table 12: Households coping strategies to protect food consumption**

Strategy	Percentage of households using strategy (n=120)
<i>Coping strategies to purchase food:</i>	
Borrowed money for food	56.7
Sell mopane worms for cash	48.3
Found extra income sources or use savings	24.2
Sold household assets	23.3
Sold livestock	13.3
Took children out of school	12.5
<i>Coping strategies to receive free food:</i>	
Asked neighbours/family relatives for help	60.0
Appeal for food aid	30.8
Depend on charity/welfare (not Gov. social grant)	22.5
Members to beg for food	4.2

**Source:** Field survey (2013)

The above Table shows that 60 percent of the households asked their neighbours and family relatives for help during food shortages. This was the most popular coping strategy adopted by

households to receive free food which is in line with the findings of Mjonono *et al.*, (2007) reported that few households to be using these strategies in the KwaZulu Natal Province.

### 5.3.2 Modifying food consumption to cope with food insecurity

Households often have to modify their consumption patterns to cope with food deficit. Households can modify consumption in three ways, either by reducing food consumption, diversify food consumption or reduce the number of food consumers in the household. The results under these options were presented in Table 13.

**Table 13: Household strategies to modify food consumption**

<b>Coping Strategy</b>	<b>Percentage of Households Using Strategy (n=120)</b>
<i>Strategies to reduce food consumption:</i>	
Reduce food intake	70.8
Reduce portion size	83.3
Skip meals	26.7
<i>Strategies to diversify food consumption:</i>	
Eat less preferred food	71.7
Restrict consumption in favour of children	43.3
Feed working members at the expense on non-working members	29.2
Gather wild food	26.7
<i>Strategies to reduce food consumers:</i>	
Send members to eat else where	44.2
Household members move elsewhere(migrate)	43.3

**Source:** Field survey (2013)

In Table 13, about 71 percent of the households reduced food intake, 83 percent reduced portion size, about 27 percent skipped meals completely and about 72 percent ate less preferred food to

cope with food shortages. The high percentages on these coping strategies are expected and in line with the findings of Devereux (1993) who reported high levels of food insecurity to be associated coping strategies that modifies food consumption. In this study, an average household is moderately food insecure (HFIAS score of 15). This implies that these households will adopt coping strategies that reduces the quantity and quality of food intake to modify their consumption as this enables the household to cope with the available food reserve through the food shortage period.

#### **5.4 Conclusion**

This chapter explored the contributions of mopane worms to household food security. This is to ensure that relevant issues are raised with regards to making viable recommendations for the next chapter. The next chapter presents the summary of the study, conclusion and recommendations.

## **CHAPTER 6**

### **SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS**

#### **6.0 Introduction**

This chapter presents the summary, and conclusion. The chapter also recommends possible improvement strategies, as well as possible research foci for individual studies.

#### **6.1 Summary**

This study examined the contribution of mopane worm activities to household food security. In order to accomplish this, three research queries were posited. The first asks of the socio-economic factors affecting households' participation in mopane worm harvesting in the Limpopo Province. The concept of participation in mopane worm harvesting was divided into two groups whereby a household is a mopane worm harvester (producer) or non-harvester. A binary logistics model was used to empirically model the two participation outcomes. The model was specified using determinants drawn from past studies examining household's participation in mopane worm activities. These variables used include gender, age, education and religion of the household head, household's size, income, food and non-food expenditure and distance to market. The results indicated the gender composition of household to influence the household's decisions to harvest mopane worms. Male headed households were less likely to harvest mopane worms compared to their female counterparts. Further, the result showed that, for any increase in the age of a household head, household size and households income increases the likelihood of the household been mopane worm harvesters whilst an increase in the years of education of a household head, households expenditure on food and a household belonging to the ZCC religion were found to decrease the probability of households been mopane worm harvesters.

The second question identified household's socio-economic characteristics that determine the rate of commercialisation of mopane worms within harvesting households. Commercialisation was calculated as a percentage of the quantity of mopane worms sold over the quantity harvested. The results showed high rates of mopane worm commercialisation with more than 50 percent of households commercialising their harvest. An Ordinary least square model (OLS) was specified to determine the factors affecting mopane worm commercialisation. The results revealed that, an increase in the frequency of mopane worm consumption, increase in per capita consumption of mopane worms, increase in the distance to market as well as a household's head been male reduces commercialisation in the household. However, other factors like increase in harvesting experience (number of years the household has been harvesting mopane worms) and mopane worm income improves mopane worm commercialisation in the household.

Finally, the third question examined the impact of mopane worms in the food security status of the households in the Limpopo Province. In order to answer this question, an ordinary least square model was used to empirically model the determinants of food insecurity. Drawing from the work of Baiyegunhi and Makwangudze (2013), the Ordinary Least Square model (OLS) was specified using the Household Food Insecurity Access scale (HFIAS) scores as a dependent variable. HFIAS scores were hypothesized to depend on mopane worm activities and some socio-economic characteristics (age of household head, gender of household head, education level of household head, household's size, income, food expenditure and distance to market). Two proxy variables were used to represent the contribution of mopane worms to food security. The first variable mopane worm income indicated the indirect contribution whilst the second: frequency of mopane worm consumption indicated the direct contribution. The results revealed that increasing in age and education level of the household head as well as in household's

income to improve households food security status whilst increase in household size and the distance to market deteriorates households food security. Moreover, the two proxy variables showed a positive relationship with household's food security implying a positive impact of mopane activities on household food security.

Further, the study used the Deveau (1993) coping strategy categorization to categorise the coping strategies used by households to combat food insecurity. The study found a majority of the households to be adopting less erosive strategies like asking neighbours/family relatives for help, borrowing money for food and selling mopane worms for cash to protect their food consumption whilst strategies like reducing food intake, portion size and eating less preferred food were adopted to modify their food consumption. Overall, the three most adopted coping strategies were reducing portion size, reducing intake and eating less preferred food which combined confirms households were mostly moderate to severe food insecure.

## **6.2 Conclusion**

The study found household socio-economic characteristics like gender, age, education, religion and others to affect mopane worm activities as well as determines mopane worm commercialisation and thus rejects the two hypothesis that households socio-economic factors do not affect mopane worm harvesting and commercialisation.

From the results and discussions on food security it may be concluded that there is a high incidence of food insecurity in the mopane district of the Limpopo Province, however, both proxy variables representing mopane worm activities (mopane worm income and frequency of mopane worm consumption) were found to be significantly positively related to food security i.e. improves food security. Thus the study fails to accept the hypothesis of no impact of mopane

worm activities on food security status of households and concludes that, mopane worm activities contributes to household food security through increasing mopane worm income (commercialisation) and increase in the frequency of consumption of the harvested mopane worms (harvesting and consumption).

On the basis of the above findings, it may be suggested that by giving special emphasis to mopane worms harvesting and commercialisation, the household food security of households in the Limpopo Province can be improved.

### **6.3 Policy recommendations**

The results of this study indicate that mopane worm activities may benefit food security through harvesting (consumption) and commercialisation which validates the previous claims of the importance of mopane worm activities to household food security. Based on the findings of this study, the following recommendations are suggested for the improvement of household's participation in mopane worm harvesting and commercialization.

Harvesters should be sensitized on the importance of market oriented mopane worm harvesting and the benefits of large scale sustainable commercialisation through workshops seminars, harvester -trader sharing platforms, and extension education. Subsequently, harvesters will appreciate the importance of harvesting large quantities of mopane worms for sales. This will generate higher incomes for households to investment in better business opportunities which in turn will increase household's participation in mopane worm harvesting and commercialisation.

Nevertheless, increasing the quantity of mopane worms harvested could have some negative environmental effect on the mopane worm as a natural resource. Depending on the rate at which mopane worms are harvested and the quantities harvested at a time, increasing harvesting



quantities could lead to over harvesting and deplete mopane worm reserves. Moreover, continuous unregulated increment in mopane worms quantities harvested could lead to the extinction of the worms in the particular community. Therefore, an effective regulatory conservation frame work is also required to control the harvesting patterns of the mopane worms. Communities need to decide how harvesting should be regulated, how these regulations can be enforced, and what penalties there might be for those who disregard the regulations. Such conservation regulatory efforts need to be developed at both local and the Rural District Council levels. At the lower resource governance levels, it is imperative that existing regulatory instruments be modified so that the roles of the traditional leadership in resource management are strengthened.

In addition, mopane worm availability is dependent on the rainfall patterns in the specific area; low rainfall and extended periods of drought may limit the abundance of the worms for harvesting to a point whereby the worms are unavailable for harvesting. Therefore, to ensure the continuous availability of mopane worms during dry seasons, communities could establish rules as to who can have access to an area to collect mopane worms; how much they can collect; and whether they should pay a levy to the community for the privilege. Such rules could also specify acceptable and unacceptable means of collecting mopane worms.

Provision of input such as harvesting protective gears, mopane worm degutting gloves and better storage facilities will motivate harvesters and also increase their productivity, especially those already commercializing in the Greater Giyani areas would be a step in the right direction as this will increase the volume of mopane worms harvested for commercialisation. And subsequently improve household food security.

There is also need to develop well-functioning information systems that are accessible and can effectively reach the widely dispersed harvesters populations with information on buyer preferences, prices, and mopane worm supply and demand levels within different regions of the Limpopo Province.

As concluded earlier, mopane worms activities contributes to households food security through income generation (commercialisation) from harvesting and the frequency of consumption, however, the study did not focus on the following: (i) the harvesting techniques used by households to ensure sustainable and continual harvesting of mopane worms; (ii) how the price of mopane worms is determined (iii) how mopane worms are sold and the channels used;

### **6.3.1 Possible research foci for individual studies**

Therefore the study recommends further studies on:

- Sustainable harvesting techniques to improve household's reliance on mopane worm harvesting.
- Determinants of mopane worm pricing among harvesting households
- The supply chain for mopane worms and where along the chain is value added.

Further, this study focuses on food security, one aspect of a household's quality of life, therefore the entirety of the benefits stemming from mopane worm activities to households livelihood as a whole is not measured, thus an empirical study on the role of mopane worms to household's livelihood in the Limpopo Province is recommended to see the actual role mopane worms play in sustaining household livelihood.

## REFERENCES

- Adekoya AE & Babaleye T (2009).** Consistency in technology adoption among farmers in: northern Nigeria. *Journal of Food, Agriculture and Environment* 7: 457-460.
- Aliber M (2009).** Exploring statistics South Africa's national household surveys: as sources of information about household-level food security. *Agrekon* 48(4): 384–409.
- Altman M, Hart TGB & Jacobs PT (2009).** Household food security status in South Africa. *Agrekon* 48(4):345-361.
- Baiphethi MN & Jacobs PT (2009).** The contribution of subsistence farming to food security in South Africa. *Agrekon* 48(4): 473 – 475.
- Baiyegunhi LJS & Makwangudze KE (2013).** Home gardening and food security status of HIV/AIDS affected households in Mpophomeni, KwaZulu-Natal Province, South Africa. *Journal of Human Ecology* 44(1): 1-8.
- Barrett CB (2002).** Food security and food assistance programs, in: Gardener B, Rausser G & Elsevier BV (eds.). *Handbook of Agricultural Economics* 2:2103-2135.
- Bashir MK, Schilizzi S & Pandit R (2012).** The determinants of rural household food security in the Punjab, Pakistan: an econometric analysis, working paper 1203, school of agricultural and resource economics, university of Western Australia, Crawley, Australia.
- Coates J, Swindale A & Bilinsky P (2007).** Household food insecurity access scale (HFIAS) for measurement of food access: Indicator Guide (v.3). Food and Nutrition Technical Assistance Project, Washington DC.
- Chavas JP (2000).** The microeconomics of food security. *The Australian Journal of Agriculture and Resource Economics* 44(1): 1-29.
- Davies S (1993).** Are coping strategies a cop-out? *IDS Bulletin* 24 (4):60-72.
- De Cock N, D'Haese M, Vink N & van Rooyen CJ (2013).** Food security in rural areas of Limpopo province: South Africa. *Food Security* 5:269–282.

**De Foliart GR (1992).** Insects as human food: discussion on some nutritional and economic aspects. *Crop Protection* 11(5):395-399.

**De Foliart GR (1995).** Edible insects as mini-livestock, *Biodiversity Conservation* 4:306-321.

**Devereux S (1993).** Goats before ploughs: dilemmas of household response sequencing during food shortages. *IDS Bulletin* 24(4):52-59.

**Devereux S (2001).** Livelihood insecurity and social protection: re-emerging issue in rural development. *Development Policy Review* 19(4): 517-519.

**D'Hase L & Vermeulen H (2011).** The food security status of Limpopo Province: .Archive of interdisciplinary discussion groups and past events [online]  
<http://blogs.sun.ac.za/fsi/files/2010/10/Presentation-food-security-limpopofinal1.pdf> (accessed 15/08/12).

**Du Toit DC, Ramonyai MD, Lubbe PA & Ntushelo V (2011).** Food security: Department Of Agriculture Forestry and Fisheries, Pretoria, South Africa.

**Dreyer JJ & Wehmeyer AS (1982).** On the nutritive value of mopanie worms. *Southern African Journal of Science* 78: 33-35.

**FAO (Food and Agricultural Organization) (2002).** The state of food insecurity in the world: Food and Agriculture Organization of the United Nations, Rome, Italy.

**FAO (Food and Agricultural Organization) (2003).** Non-wood news: Food and Agriculture Organization of the United Nations, Rome, Italy.

**FAO (Food and Agriculture Organisation) (2008).** The state of food insecurity in the world: how does international price volatility affect domestic economies and food security? FAO's Agriculture and Development Economics Division (ESA): Rome, Italy.

**FAO (Food and Agricultural Organization) (2009).** The state of food insecurity in the world economic crises: impacts and lessons learned: Food and Agriculture Organization of the United Nations, Rome Italy.

**FAO (Food and Agricultural organization) (2010).** The state of food insecurity in the world: addressing food insecurity in protracted crises: Food and Agricultural Organization of the United Nations, Rome, Italy.

**FAO (Food and Agricultural organization) (2011).** World food and agriculture in review: Food and Agricultural Organization of the United Nations, Rome Italy [online] <http://www.fao.org/docrep/013/i2050e/i2050e00.htm> (accessed 18/10/2012).

**FAO (Food and Agriculture Organisation) (2012).** Assessing the potential of insects as food: and feed in assuring food security: Summary report technical consultation meeting, Food and Agricultural Organization of the United Nations, Rome, Italy.

**Frankenberger T (1992).** Indicators and data collection methods for assessing household food security; Household food security: Concepts, indicators, and methods [Online] [http://www.ifad.org/gender/tools/hfs/hfspub/hfs\\_2.pdf](http://www.ifad.org/gender/tools/hfs/hfspub/hfs_2.pdf) (accessed 18/10/2013).

**Ghazoul J (2006).** Mopane woodland and the mopane worm: enhancing rural livelihoods and resource sustainability, final technical report, division of biology, Imperial College, London.

**Gondo T, Frost P, Kozanayi W, Stack J & Mushongahande M (2010).** Linking knowledge and practice: assessing options for sustainable use of mopane worms (*Imbrasia Belina*) in Southern Zimbabwe. *Journal of Sustainable Development in Africa* 12(1): 281-305.

**Govere J, Jayne TS & Nyoro J (1999).** Smallholder commercialization, interlinked markets and food crop productivity: Cross-country evidence in eastern and southern Africa [Online] [http://www.aec.msu.edu/fs2/ag\\_transformation/atw\\_govere.PDF](http://www.aec.msu.edu/fs2/ag_transformation/atw_govere.PDF) (accessed 2/10/2013)

**Gujarati DN (2004).** Basic Econometrics (Fourth Edition), NY, McGraw-Hill, Inc.:597-804.

**Hailu A & R Nigatu (2007).** Correlates of household food security in densely populated areas of Southern Ethiopia: does the household structure matter. *Studies on Home and Community Science Journal* 1: 85-91.

**Hart TG (2009).** Exploring definitions of food insecurity and vulnerability: time to refocus assessments *Agrekon* 48(4): 362-383.

**Hoddinott J (1999).** Choosing outcome indicators of household food security: International Food Policy Research Institute: Washington DC, USA.

**Holben DH (2002).** An overview of food security: and its measurement. *Nutrition Today* 37(4): 156-162.

**Hope RA, Frost PG, Gardiner A & Ghazoul J (2009).** Experimental analysis of adoption of domestic: mopane worm farming technology in Zimbabwe. *Development Southern Africa* 26(1): 29-46.

**Illgner P & Nel E (2000).** The geography of edible insects in Sub-Saharan Africa: a study of the mopane caterpillar. *The Geographical Journal* 166(4): 336-351.

**Imbens GW & Lancaster T (1996).** Efficient estimation and stratified sampling. *Journal of Econometrics* 74(2): 289-318.

**Ivers LC & Cullen KA (2011).** Food insecurity: special considerations for women. *The American Journal of Clinical Nutrition* 94(6): 1740S-1744S.

**Kirsten J, Townsend R & Gibson C (1998).** Determination of agricultural production to household nutritional status in: KwaZulu-Natal, South Africa. *Development Southern Africa* 15(4): 573-587.

**Kozanayi W & P Frost (2002).** Marketing of mopane worm in southern Zimbabwe: unpublished report, institute of environmental studies: University of Zimbabwe, Zimbabwe.

**Labadarios D, Swart R, Maunder EMW, Kruger HS, Gericke GJ, Kuzwayo PMN, Ntsie PR, Steyn NP, Schloss I, Dhansay MA, Jooste PL, Dannhauser A, Nel JH, Molefe D & Kotze TJVW (2008).** National Food Consumption Survey-Fortification Baseline (NFCS-FB-I) South Africa, 2005. *South African Journal Clinical Nutrition* 21(3) (Supplement 2): 245-300.

**Lamb JNT (2011).** Food security and social networks: impacts for smallholder farmers in the Mount Elgon region of Kenya and Uganda. MSc Thesis: Virginia polytechnic and state university, Blacksburg, Virginia, USA.

**Limpopo-DLGH (2007).** Districts and Municipalities. [Online] <http://www.limpopo-dlgh.gov.za> (accessed 08/12/2012)

**Lucas TL (2010).** The evolution and impacts of mopane worm harvesting: perceptions of harvesters in central Botswana. MSc Thesis, University of the Witwatersrand, Johannesburg. South Africa.

**Makhado RA, Von Maltitz GP, Potgieter MJ & Wessels DC (2009).** Contribution of woodland products to rural livelihoods: in the northeast of Limpopo Province, South Africa. *South African Geographical Journal* 91(1): 46-53.

**Makhura MT (2001).** Overcoming transaction costs barriers to market participation of smallholder farmers in the Northern Province of South Africa .Doctoral dissertation, University of Pretoria, Pretoria, South Africa.

**Malepane A (2012).** Project consultant: Department of Agriculture, Fisheries and Forestry. Giyani: Limpopo Province, South Africa.

**Maxwell DG (1996).** Measuring food insecurity the frequency: and severity of coping strategies. *Food Policy* 21(3): 291-303.

**Mjonono M, Ngidi M & Hendriks S (2012).** Investigating household food insecurity coping strategies: and the impact of crop production on food security: using coping strategy index (CSI). In 17th International Farm Management Congress.

**Moruakgomo MBW (1996).** Commercial utilisation of Botswana's veldt products – the economics of phane: the dimensions of phane trade. in BA Gashe & SF Mpuchane (eds), Phane, Proceedings of the First Multidisciplinary Symposium on Phane 18 June, Department of Biological Sciences, Gaborone, Botswana.

**Mpuchane S, Gashe BA, Allotey J, Siame B, Teferra G & Dithlogo M (2000).** Quality deterioration of phane, the edible caterpillar of an emperor moth *Imbrasia belina*, Food Control 11: 453–458.

**Muregerera H (2008).** Direct uses of communal rangelands [online]  
<http://ufh.netd.ac.za/bitstream/10353/175/8/Muregerera%20H%20thesis%20chap7.pdf>.  
(Accessed 23/06/2013).

**Mushongahande M (2003).** Mopane worm annual project report: mopane woodlands and the mopane worm: enhancing rural livelihoods and resource sustainability, DFID Project no. R7822, Forestry Commission of Zimbabwe.

**Oppong CK, Addo-Bediako A, Potgieter MJ & Wessels DCJ (2009).** Distribution of the eggs of the mopane psyllid *Retrocizzia mopani* (Hemiptera: Psyllidae) on the mopane tree. *African Invertebrates* 50(1): 185-190.

**Rebe M (1999).** The sustainable use of mopane worms as a harvestable protein source for human consumption: Local perceptions. Unpublished MSc Thesis: University of Pretoria. Pretoria, South Africa.

**Ruhangawebare GK (2010).** Factors affecting the level of commercialization among cattle keepers in the pastoral areas of Uganda (No. 117797): Collaborative Master's Program in Agricultural and Applied Economics. Makerere University, Uganda.

**SAFIRE (2013).** Mopane worms [online]  
[http://www.safireweb.org/index.php?option=com\\_content&task=view&id=43&Itemid=54](http://www.safireweb.org/index.php?option=com_content&task=view&id=43&Itemid=54)  
(accessed 20/11/2013).

**Sakyi P (2012).** Determinants of food accessibility of rural households in the Limpopo Province: South Africa. MSc thesis: Gent University, Belgium.

**Sen A (1981).** Poverty and famines: An essay on entitlement and deprivation. Oxford: Clarendon press.



**Senyolo GM, Chaminuka P, Makhura MN & Belete A (2009).** Patterns of access and utilization of output markets by emerging farmers in South Africa: Factor analysis approach. *African Journal of Agricultural Research* 4(3):208-214.

**Shackleton CM & Shackleton SE (2004).** The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. *South African Journal of Science* 100(11 & 12): 658-664.

**Shisana O, Labadarios D, Rehle T, Simbayi L, Zuma K, Dhansay A, Faber M & the SANHANES-1 Team (2013).** South African National Health and Nutrition Examination Survey (SANHANES-1):145.

**Stack J, Dorward A, Gondo T, Frost P, Taylor F & Kurebgaseka N (2003).** Mopane worm utilisation and rural livelihoods in Southern Africa: In CIFOR Livelihood Conference May 19-23.

**Styles CV (1994).** The big Value in mopane worms: Farmer's weekly newspaper, July 22

**Taylor F (2003).** Mopane worm (MW) utilisation and rural livelihoods in Botswana: preliminary field survey report: Veld products Institute, Botswana.

**Timberlake J (1996).** Colophospermum mopane - a tree for all seasons, in: Mushove PT, Shumba EM & Matose F (eds.). Sustainable management of indigenous forests: in the dry tropics: Zimbabwe Forestry Commission, Zimbabwe.

**Thomas B (2013).** Sustainable harvesting and trading of mopane worms (*Imbrasia belina*) in Northern Namibia: an experience from the Uukwaluudhi area. *International Journal of Environmental Studies* 70(4): 494-502.

**Toms RB, Thagwana MP & Lithole KD (2003).** The mopane worm: indigenous knowledge in the classroom [Online] [www.scienceinafrica.co.za](http://www.scienceinafrica.co.za) (Accessed 13/08/2012).

**Van der Merwe C (2011).** Key Challenges for ensuring food security in South Africa's inner cities. AISA Policy Brief 36: 1-7.

**Van Huis A (2013).** Potential of insects as food and feed: in assuring food security. *Annual Review of Entomology* 58:563-583.

**Von Braun J & Immink MDC (1994).** Non-traditional vegetable crops and food security among smallholder farmers in Guatemala In: von Braun J & Kennedy E (eds.). Agricultural commercialization, economic development, and nutrition. Johns Hopkins University Press, Baltimore, MD: 189-203.

**WHO (World Health Organisation) (2012).** Food security: trade, foreign policy, diplomacy and health [Online] <http://www.who.int/trade/glossary/story028/en/> (accessed 11/09/2012).

## APPENDIX 1

**Table 14: HFIAS module**

Question number	HFIAS questions
Q1	Worried that food would run out
Q2	Eat un-preferred food
Q3	Eat limited variety of food
Q4	Eat what you didn't want to eat
Q5	Reduce portion size
Q6	Skip meals in a day
Q7	No food at all in the household
Q8	Went to sleep hungry
Q9	Did not eat for a whole day

*Adapted from Coates et al., (2007)*

**Table 15: HFIAS indicator guide**

	HFIAS category
1 (food secure)	if [(Q1a=0 or Q1a=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]
2 (mildly food insecure)	if [(Q1a=2 or Q1a=3 or Q2a=1 or Q2a=2 or Q2a=3 or Q3a=1 or Q4a=1) and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0].
3 (moderately food insecure)	if [(Q3a=2 or Q3a=3 or Q4a=2 or Q4a=3 or Q5a=1 or Q5a=2 or Q6a=1 or Q6a=2) and Q7=0 and Q8=0 and Q9=0].
4 (severely food insecure)	if [Q5a=3 or Q6a=3 or Q7a=1 or Q7a=2 or Q7a=3 or Q8a=1 or Q8a=2 or Q8a=3 or Q9a=1 or Q9a=2 or Q9a=3].

*Adapted from Coates et al., (2007)*

**Table 16: Binary logit regression model output**

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	114.114 <sup>a</sup>	.353	.471

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Classification Table <sup>a</sup>				
	Observed	Predicted		
		GROUP		Percentage Correct
		Non-harvesters	Harvesters	
Step 1	Non-harvesters	48	12	80.0
	Harvesters	15	45	75.0
	Overall Percentage			77.5

a. The cut value is .500

Hosmer and Lemeshow Test			
Step	Chi-square	df	Sig.
1	12.855	8	.217

Variables in the Equation							
	B	S.E.	Wald	df	Sig.	Exp(B)	
Step 1 <sup>a</sup>	gender	-1.065	.515	4.282	1	.039	.345
	HHage	0.33	.023	6.63	1	.010	1.39
	Edu	-.041	.041	.970	1	.325	.960
	HHsize	.569	.181	9.894	1	.002	1.766
	Religi(Pent)	1.631	.942	2.993	1	.084	5.107
	Religi(ZCC)	-0.870	.835	4.156	1	.041	.420
	Religi(Cath)	-1.253	.876	2.044	1	.153	.286
	HHInc	.451	.163	7.703	1	.006	1.571
	Nonfex	.001	.001	1.054	1	.305	1.001
	Fex	-1.157	.721	7.350	1	.007	0.31
	Dmkt	.091	.113	.659	1	.417	1.096
	Constant	-5.866	2.589	5.135	1	.023	.003

**Table 17: Mopane worm commercialisation model output**

R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig.
Rate of commercialisation = high rate of commercialisation (>50%) (Selected)					
.716	.513	.339	10.02071	2.946	.012

Coefficients <sup>a,b</sup>							
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	75.851	14.768		5.136	.000		
1 gender	-1.033	.408	-.106	-2.531	.020	.718	1.393
HHage	.034	.173	.032	.196	.846	.635	1.576
Edu	.038	.301	.020	.127	.900	.668	1.498
Dharvsite	1.393	1.073	.197	1.299	.205	.757	1.321
Hexper	.968	.518	.285	1.869	.072	.749	1.336
Frecon	-2.764	1.151	-.355	-2.402	.023	.796	1.256
Mwi	.013	.004	.602	3.017	.005	.437	2.289
PPC	-10.390	2.858	-.779	-3.636	.001	.379	2.641
Dmkt	-1.412	.496	-.332	-2.847	.007	.665	1.504

a. Dependent Variable: ratecommecialization

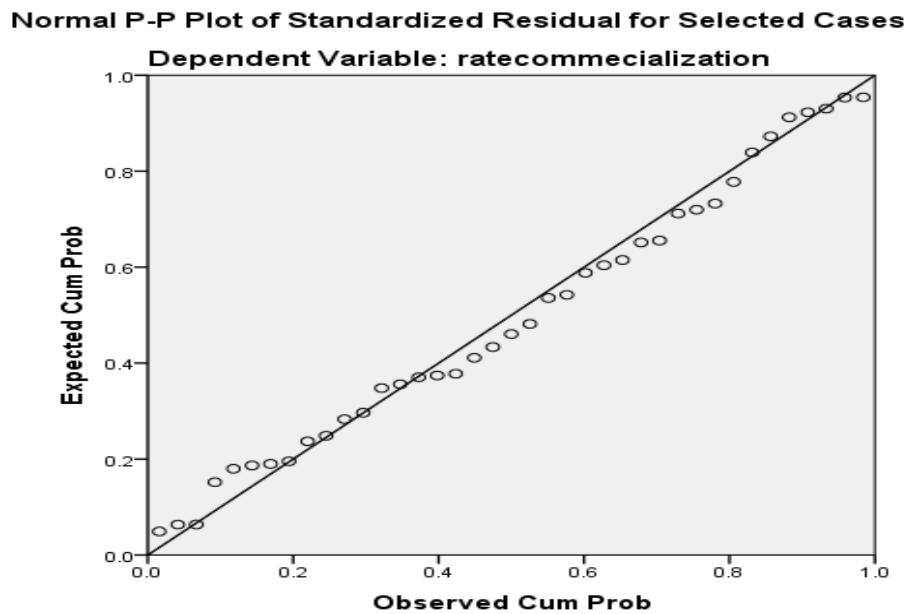
**Table 18: Ramsey Test for the commercialisation model**

Coefficients <sup>a,b</sup>					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 comRESQUARE	.005	.004	.072	1.124	.270

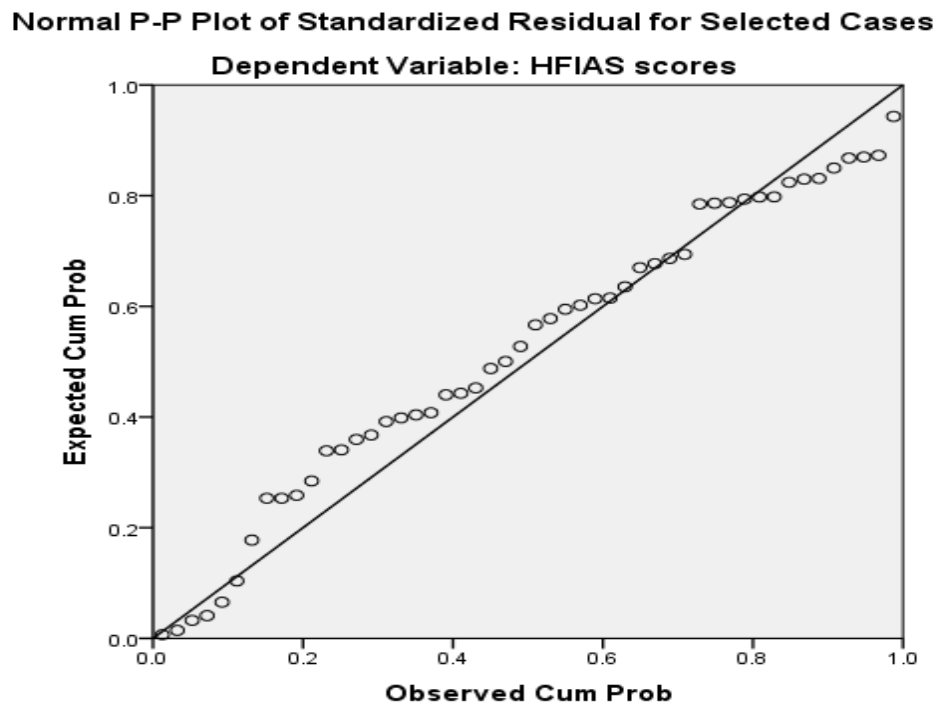
a. Dependent Variable: ratecommecialization

b. Selecting only cases for which Rate of commercialisation = high rate of commercialisation (>50%)

**Figure 4: Normal P-P plot for the commercialisation model**



**Figure 5: Normal P-P plot for the commercialisation model**



**Table 19: Household food security model output**

Model Summary						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig.
	food security score threshold = food insecure (Selected)					
1	.813a	.661	.585	4.28212	8.674	.000

a. Predictors: (Constant), Frecon gender, HHage, Edu, HHsize, HHInc, Fex, Dmkt, Mwi

Coefficients <sup>a,b</sup>							
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	14.522	4.700		3.090	.004		
gender	.298	1.445	.022	.206	.838	.761	1.315
HHage	-.016	.009	-.134	-1.811	.078	.666	1.501
Edu	-.007	.001	-.908	-10.618	.000	.644	1.553
HHsize	1.453	.478	.341	3.040	.004	.685	1.459
<sup>1</sup> HHInc	-.897	.340	-.325	-2.636	.012	.458	2.184
Fex	.311	.638	.083	.488	.628	.738	1.355
Dmkt	.970	.352	.352	2.757	.009	.530	1.887
Mwi	-1.339	.459	-.316	-2.921	.006	.682	1.467
Frecon	-.924	.383	-.201	-2.413	.018	.681	1.469

a. Dependent Variable: HFIAS scores

b. Selecting only cases for which food security score threshold = food insecure

**Table 20: Ramsey Test for the food security model**

Coefficients <sup>a,b</sup>					
HFIAS scores	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 FSRESQUARE	.016	.676	.003	.023	.982

b. Selecting only cases for which food security score threshold = food insecure

## APPENDIX 2

### Questionnaire

The Department of Agricultural Economics, University of KwaZulu-Natal is appealing for your assistance. The assistance requested is in the form of a few minutes of your time. We are busy conducting a study aimed at identifying the potential contribution of mopane worms to household food security in Limpopo Province.



Enumerator (name and number)	
Village Name	
Name of respondent	
Contact details of respondent (cell no.)	
Questionnaire Number (do not fill)	



## SECTION A: HOUSEHOLD DEMOGRAPHICS

**A. Are you the head of the household? YES (1) NO (0)**

If NO, then what is your relationship to household head?

\_\_\_\_\_

### B. Information on household's head only

	<b>C. Age in YEARS</b> (at last birthday)	<b>D. Gender</b> Male:1 Female:2	<b>E. What is the highest education or qualification attained by this person?</b> 1= no schooling 2 = primary 3 = high school 4= tertiary	<b>F. Are you employed ?</b> YES(1) NO(0)	<b>G. Type of income received per month</b> 1=Salary 2=pension 3=grant income 4=remittances	<b>H. Religion</b> 1=Pentecostals 2=ZCC 3=Catholic 4=Lutheran 5=Muslim 6= No religion 7=other, please specify
Head						

**I. What type of house do you live in? (1)Face brick house (2) RDP house (3) Shack (4) other please specify----- (observation by the enumerator)**

**J. How many people live in the household? .....(in number)**

**K. Is the house connected to an electricity supply? YES (1) NO (0)**

**L. Does the household have to fetch and carry water to the house each day? YES (1) NO (0)**

**M. What kind of toilet does the household use? Please tick the appropriate answer (only one)**

(1) Flush toilet inside home	
(2) Improved pit latrine with ventilation(VIP) on the stand	
(3) Bucket toilet	
(4) Chemical toilet	
(5) other (specify)	

**N. Does any person in this household have the right to use (have access to) any land for arable farming, that is, to grow and cultivate crops on? YES (1) NO (0)**

**O. IF YES, What is the size of this land?.....( in hectares)**

**P.** Are any of the following facilities within 30 minutes (2 km) walk of your house?

Facility	Distance in km	Distance in walking time (min.)
Shop where basic food can be bought		
Market to buy goods and food		
Markets where you can sell goods and food, if different		
Bank		
Post office		

### A3. Household income

**A.** What is your household's main source of income and **HOW MUCH** is received from this source throughout the year? **(please answer the part that is applicable)**

Formal salary or wages	Amount received from this source	Small business( self-employed)	Amount received from this source	social grant and assistance	Amount received from this source
Salary	R	Food crop production/sales	R	Grant for older persons (pension)	R
Wages (per week)	R	Livestock production/sales	R	Disability grant	R
Other(please specify)	R	Mopane worm sales	R	Child support grant	R
		Fishing/sales	R	Foster care grant (adoption)	R
		Brewing(homemade beer sales)	R	Other grants (please specify)	R
		Vegetable and fruit production/ sales	R		
		<b>Other (please specify)</b>	R		
<b>Total INCOME</b>	<b>R</b>	<b>Total INCOME</b>	<b>R</b>	<b>Total INCOME</b>	<b>R</b>

**B.** Does the household receive money (or other contributions) from the migrants (**household members staying and working in other places other than home**)? YES (1) NO (0)

If **YES**, how often do you receive money (or other contributions)? (1) Monthly (2) every few months (3) Once a year (4) other (please specify)

How much of the income you received from the migrants per month?.....(Rand)

## SECTION B: FOOD SECURITY AND HOUSEHOLD'S CONSUMPTION

### B1. Household Consumption

**B11.** In the last month, how much, if anything, did the household pay in cash and credit for:

Item	Amount (R)	product	Amount(R)	Item	Amount (R)
Cereals(mielie meal, rice etc)		eggs		Education(School fees, books etc)	
Roots and tubers(potatoes, sweet potatoes etc)		chicken		Bonds(rent etc)	
Bread		Milk and milk products(cheese, yogurt)		Water and electricity	
Legumes(bean, peas, peanuts)		Beverages(tea, soft drinks etc)		Communications (airtime, internet, phones, telephone etc)	
Red meat (Beef)		Personal items (clothes, shoes etc)		Loan repayments, Interest on loans	
Mutton		Fruits and vegetables		Medical care(medical aid, health insurance)	
Goat		Oil, butter		Other payments made in the last month	

### B12. Farming expenses

Other farming materials/ equipment Seeds/planting material		Petrol, diesel and oil for farm machines		Farm land that was rented from someone else	
Fertilizer, Pesticides, Herbicides		Food for the poultry or farm animals		Various services, for example for tractors, oxen which were used for ploughing	
Wages for workers who		Any other farm related costs			

helped with farming		(please describe)			

### **B12. Households food security**

Please answer whether this happened: **never, rarely (once or twice), sometimes (3 to 10 times) or often (more than 10 times) and always (everyday)** in the past 30 days.

<b>Household Food Insecurity Access Scale (HFIAS)</b>	<b>Never</b>	<b>Rarely</b>	<b>Sometimes</b>	<b>Often</b>	<b>Always</b>
1. Did you worry that your household would not have enough food?					
2. Were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?					
3. Did you or any household member have to eat a limited variety of foods due to a lack of resources?					
4. Did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?					
5. Did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?					
6. Did you or any household member have to eat fewer meals in a day because there was not enough food?					
7. Was there ever no food to eat of any kind in your household because of lack of resources to get food?					
8. Did you or any household member go to sleep at night hungry because there was not enough food?					
9. Did you or any household member go a whole day and night without eating anything because there was not enough food?					

**B13.** If your household **did not have enough food available**, how **did** your household **cope** with this?

	YES (1)	NO(0)
A. Eat less preferred food		
B. Reduce food intake		
C. Buy food on credit		
D. Borrow food		
E. Exchange one type of food for another		
F. Consume seed stock		
G. Send members to eat elsewhere		
H. Send members to beg		
I. Limit or reduce portion size		
J. Restrict consumption in favour of children		
K. Feed working members at the expense of nonworking members		
L. Sell mopane worms for cash		
M. Skip meals for an entire day		
N. Gather wild food		
O. Asked neighbours/ family relatives for help		
P. Found extra income sources or use savings		
Q. Household members moved elsewhere		
R. Sold household assets		
S. Sold livestock		
T. Appeal for food aid		
U. Depended on charity/welfare (no social grants		
V. Borrowed money for food		
W. Took children out of school		

## Section C MOPANE WORM ACTIVITIES

Please ask for local units of measurement when answering the following sections.

**Enumerator:** Please note that households are only allowed to answer sections appropriate to them. For example, if a household harvest (collects) mopane worms to eat or sell or both, then answer only section C2. If a household don't collect mopane worms, but buy mopane worms to eat or sell or both the answer only section C31 AND C32.

	Yes	No
I harvest mopane worms for selling only		
I harvest mopane worms for consumption only		
I buy mopane worms for selling only		
I buy mopane worms for consumption only		

If all the answers are NO, reason? 1 Not interested

3 don't know it

2 Religious issues

4 don't like mopane worms

5 other (please specify)

### SECTION C2: MOPANE WORM HARVESTING

**C22.** How long have you been harvesting mopane worms? \_\_\_\_\_ (years)

**C23.** How many kg of mopane worms were harvested in the past 12 months?..... (use buckets to measure)

Do you sell some of the harvested mopane worms? Yes    No

If yes, how much in kgs do you sell per season? .....

How much in Rands is 1 kg of mopane worms?.....

**C24.** Do all the household members consume (eat) mopane worms? **YES (1) NO (0)**

\_\_\_\_\_

IF NO how many consumes?

How many days in a week do you eat mopane worms?.....

How many in kgs do you eat per week?.....

## SECTION C3: PURCHASING

**This section is for households buying mopane worms either to eat (consume) or sell (trade)**

### **C31 buying**

A. What's your reason for buying in mopane worms? (1) It is the only source of income for my family. (2) To provide extra income for my family (3) other please specify.....

B. How long have you been a mopane worm trader?..... (Years)

C. Where do you buy your mopane worms to sell? (1) Supermarkets (pick n pay and spar) (2) from wholesalers in other villages (3) Street vendors in my village (4) from bus stations (5) tuck shops

(6) Please specify .....

D. Distance from home to where mopane worms are sold. Eg distance to the supermarket or street vendor? ..... (in kilometers).

E. How many kg's of mopane worms do you buy?..... (please use local units).

F. How much is a Kg (pack) of mopane worms when you buy from your source?.....

G. Can you negotiate the price when you buy mopane worms from your source? YES (1) NO (0)

### **C32 selling**

A. Do you sell all the mopane worms you buy? YES (1) NO (0)

B. If NO, How much of it do you sell?.....kg

C. how much is a kg or pack you sell your mopane worms?.....

D. What happens to the rest of your mopane worms you don't sell? (1) We consume at home (2) we store it (3) other please specify .....

**C33 consuming (to eat)**

A. Do all the household members consume (eat) mopane worms? **YES (1) NO (0)**

B. IF NO how many consumes?

C. How many days in a week do you eat mopane worms?.....

D. How many in kgs do you eat per week?.....

THANK YOU FOR YOUR TIME.