

**COMMERCIALISATION OF UNDER-UTILISED EDIBLE INSECTS IN
BENUE STATE, NIGERIA**

BY

GODWIN, Rosemary

B. Agric (Hons.) Abeokuta, M.Sc. (Hons.) Ilorin

(12/68AI007)

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CERTIFICATION

This is to certify that this thesis has been read and approved as meeting the requirement of the Department of Agricultural Economics and Farm Management, University of Ilorin, Ilorin, Nigeria, for the award of Doctor of Philosophy (Ph.D.) degree in Agricultural Economics.

Prof. O.A. Omotesho
(Supervisor)

DATE

Dr. A. Falola
(Postgraduate Coordinator)

DATE

Prof. M.O. Adewumi
(Head of Department)

DATE

Dr. A.K. Musa
(Internal/External Examiner)

DATE

(External Examiner)

DATE

DEDICATION

This thesis is dedicated to God almighty and to my late parents Mr. and Mrs. Godwin Ominyin for their unconditional love and sacrifice which has been the wind beneath my wing.

DECLARATION

I, GODWIN ROSEMARY, a Ph.D. student in the Department of Agricultural Economics and Farm Management, University of Ilorin, Ilorin, hereby declare that this thesis entitled “Commercialisation of Under-utilised Edible in Benue State, Nigeria”, submitted by me is based on my actual and original work. Any materials obtained from other sources or work done by any other person or institutions have been duly acknowledged. In addition, the research has been approved by the University of Ilorin Ethical Review Committee.

Godwin Rosemary
(12/68AI007)

Date

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ABSTRACT

Under-utilised edible insects' species have enormous potentials for entrepreneurial opportunities in Nigeria. In addition, they provide an essential component of human diet for sustainable livelihood.

Formulating sound policies on harnessing the full potentials of under-utilised edible insects requires a deep knowledge of their current commercialisation level. This study examined the extent of commercialisation of under-utilised edible insects in Benue State. The objectives of the study were to: (i) enumerate under-utilised edible insects harvested by the rural households in the study area; (ii) determine the level of commercialisation of under-utilised edible insects among rural households; (iii) examine factors affecting the extent of commercialisation of under-utilised edible insects; (iv) evaluate the returns generated from the commercialisation of under-utilised edible insects; and (v) determine the contribution of commercialisation of under-utilised edible insects to the livelihood status of rural households.

The study was a cross sectional survey using two-stage sampling procedure. Primary data were obtained from 156 rural households that were involved in the commercialisation of under-utilised edible insects in Benue State. The data collection using a structured interview schedule started in August, 2018 and ended in May, 2019. First stage of the sampling procedure involved the purposive selection of 5% out of the 368 rural communities in Benue State. The second stage involved a snowball sampling of rural households. Household Commercialisation Index, descriptive statistics, Tobit regression model, marketing margin and Ordinary Least Square regression model were employed to analyse the data.

The findings of the study were that:

- (i) the proportion of crickets, termites, caterpillars, grasshoppers and palm weevils harvested by the rural households in the study area were 30.13%, 44.87%, 12.18%, 5.13% and 7.13%, respectively;
- (ii) the majority (81%) of the rural households commercialised most of the under-utilised edible insects harvested at 85.19%, 81.89%, 81.60%, 85.12%, and 85.92% extent of commercialisation for cricket, termite, caterpillar, grasshopper and palm weevil respectively;
- (iii) the factors affecting the extent of the commercialisation of under-utilised edible insects using Tobit regression model were gender ($p = 0.1$), marital status ($p = 0.05$), years of schooling of household head ($p = 0.1$), annual income ($p = 0.01$), and household size ($p = 0.01$);
- (iv) a total of 138 kg of crickets, 104 kg of termites, 102 kg of caterpillars, 103 kg of grasshoppers and 122 kg of palm weevils were commercialised with the net returns of ₦47,931.00, ₦41,106.00, ₦40,461.00, ₦42,063.00 and ₦44,917.00 per season respectively; and
- (v) commercialisation of under-utilised edible insects significantly enhanced the livelihood status of the rural households ($R^2 = 67.4\%$). Other significant variables of the Ordinary Least Square regression result were primary occupation of the household head ($p = 0.1$), distance of home to nearest village market ($p = 0.05$), and amount of credit received by the household head ($p = 0.05$).

The study concluded that commercialisation of harvested under-utilised edible insects has positive impact on the livelihood status of the rural households in the study area. The study recommended that farmers be encouraged to commercialise more of these under-utilised edible insect

CHAPTER ONE

1.0

INTRODUCTION

1.1 Background to the Study

The word insect is generated from insectum; a latin word which means that its body is separated into sections. These insects belong to an “arthropod group that possess a chitinous exoskeleton, a three-part body (head, thorax, and abdomen), three duos of connected legs, composite eyes and double tentacles. They are amongst the highest different animal groups on the earth: more than a million insects’ species have been defined, and this is over half of all known existing organisms. The aggregate number of insects’ species is projected at 6–10 million, and the group possibly denotes more than 90 percent of the different organism on the planet” (Harpe and McCormack, 2001). Insects could be found virtually in all environs, some in the water body called the crustaceans. Many of these insects’ species are good for consumption and entomophagy therefore is the practice of consuming edible insects’ species. Just like insects animals like spiders, lizards, and birds, are entomophagous. For millennia now, individuals all over the world have been consuming edible insects’ as parts of their steady food (Arnold, Joost, Harmke, Esther, Afton, Guila and Paul 2013)

Edible insects are particularly those insects, which are not harmful and are considered safe for man consumption. These edible insects are high in protein, vitamin, and amino acid content. Also, they do not produce toxic gases such as ammonia, which is harmful to the environment. These insects are widely used in preparation of food & beverages, and animal concentrates. Some of the edible insects used in food industry are “caterpillars, bees, ants, and wasps, beetles, scale insects, grasshoppers, crickets, locusts, and mealworm”. (Market research, 2018).

Insects species are the largest organism on the planet; the enormous biodiversity harbored by the insects species is revealed in the famous element of truth that this simple group of arthropod has abundant species than all the other group of living animals pooled. Truly, insects species' in the animal kingdom constitute as greatly as 80%. (Premalatha, Abbasi and Abbasi, 2011). Currently, above 1,600 insects species are deliberately consumed by man, but beliefs are greatly variable, covering the range from dynamic prevention to irregular and significant consumption (Raubenheimer and Rothman, 2012). Although in the developed countries, eating of edible insects species by most humans disgust them whereas those that consumed them regards them as "food more for their novelty than their nutrient, for instance, they are embedded in chocolates or ice cream" (Johnson, 2010), or as a "means of existence when desert adventures go wrong" (Yoshimoto, 1999). Nevertheless, this might not be applicable to all situation; in Japan, for instance, edible insects species are consumed as part of their local diet (Nonaka, 2010), and in "some parts of Italy (Overstreet, 2003) and Croatia (Miokovic, Zivkovic, and Kozacinski, 1997) the cheese maggot (*Piophilidae casei* L.) is regarded as a delicacy".

"In many developing countries and among various beliefs spread all over the world, edible insects species remain a vital and favorite food and an indispensable source of protein, fat, minerals and vitamins" (Durst and Shono, 2010). Several edible insects species are more nutritious when likened to beef and fish, whereas others have a greater percentage of proteins and fat as well as energy value (De Foliart, 1992). In Africa, edible insects species are not consumed as alternative diet to solve hunger but are incorporated as a regular part of the food during the year or in periods when they occur (Banjo, Lawal and Songonuga, 2006). However, these insects fall into the class of Under-utilised species.

Under-utilized species (US) are valuable classes of plants and animals which include yeasts, edible insects and fish, to which minute care is given or that are totally ignored by researchers, educators, breeders, extensionists, and policymakers. Domestication of these edible insects species is been done by indigenous people, while some are collected from the forest. Factors such as absence of awareness, reduced investment in their expansion and inadequate man capacity and institutional capacity have affected their farming and extensive use of these under-utilised species (Joelinjatovo, 2015). US are “those species with under-exploited prospective for contribution to food security, health (nutritional/medicinal), income generation, and environmental services” (Jaenicke and Hoeschle-Zehlendon 2006). Alternative word to US “are ‘orphan species’, meaning they presently have no experts or research efforts going into them”. US are “sometimes referred to as ‘promising species’, for example in emerging markets or because of previously unrecognized value traits, or as ‘niche species’ due to their negligible significance in production systems and economies” ([Neglected and under-utilised species, 2014](#)). Under-utilized species are frequently called ‘minor species’ this is because “they are less significant than staple crops and agricultural commodities in terms of global production and market value”. Nevertheless, these under-utilised species are barely minor to the rural dwellers who rest on many of them for nutrition and incomes. (IPGR, 2002).

A number of these under-utilized species are rich in nutrition and requires low agricultural input. The wearing away of these species, be it wild, domesticated or cultured, can have instant effect on the food security and general welfare of the rural poor. Their greater utilization can lead to improved nutrition and better dietary intake. In addition, a lot of under-utilized fruits and vegetables comprise “more vitamin C and pro-vitamin A than widely available commercial species and varieties”. Neglected and under-utilised grains such as “quinoa (*Chenopodium quinoa*) or fonio (*Digitaria exiles*) contain healthier protein value than most cereals. The

Bambara groundnut (*Vigna subterranea*), from Africa, is very high in protein (24%), with greater percentage of the important amino acid methionine than most other leguminous crops”. (IPGR, 2002)

Many of these under-utilised species which are nutritionally rich and valued culturally across the provinces suffer abandonment and may be falling into neglect. Directing attention to these species is a real approach to help sustain the various and healthy diet available to the rural poor and to fight micronutrient insufficiencies, starvation’, and other nutritional deficiencies mainly “among the rural poor and the more susceptible social groups in developing countries”. Focusing our attention on these species is key. (IPGR, 2002)

Nigeria as a nation is endowed with plentiful resources. Despite these abundant natural resources, the dwellers still suffer as a result of declining revenue, growing poverty, food insecure, socio-economic deprivation among many others. Although, in Nigeria, nearly 70 percent live in the rural areas and farming has been supporting the livelihood of “over three-quarter of them” (NBS, 2006; Oluwatayo, 2008). However, an ample number of resources which is present in these rural areas that ought to support their livelihood and boost their welfare are either ignored or under-utilised. These species of plants and animals, as well as non-timber forest products, are ignored by researchers and agricultural policies, and hence remain underutilized (FMEnv, 2008). Nevertheless, the issue of hunger, poverty, and malnutrition can be addressed with Underutilized Edible Insects and therefore there is need to make these insects available in the market. According to Govereh, Jayne, Nyoro (1999) “Commercialization is defined as the quantity of agricultural production that is sold”. In this sense, farmers increase their market participation by commercializing. In the literature, participating in the “market is both a cause and a consequence of development”. Markets give households the chance of

benefitting from trade, this means that households can trade their excesses and procure goods and services, based on their relative advantage (Boughton, Mather, Benfica, Abdula, Tschirley and Cunguara, 2007; Barrett, 2007; Barrett, 2008). Harvesting and processing of these edible insects species for trade provide entrepreneurial and livelihood opportunities for many individuals all over the world. These activities traditionally, were considered local and are mostly under-recognised. In the recent time, however, classy, broader and extensive marketing edible insects species have been innovative including eye-catching packaging and promotion. In some countries, collecting and raising edible insects species as micro livestock at both the family level or business scale can provide a significant livelihood opportunities for people. Some of the vulnerable groups for instance the women and the homeless in both the urban and rural settings in the developing countries can simply be involved in the collecting, farming, processing and trading of edible insects species. These events can directly enhance their own nutrition and offer them cash through the marketing of surpluses as street snacks.

Putting into consideration the popularity of these edible insect species, it is not amazing that “scores of species have existed and are prominent articles of trade in the town and community markets of Africa, tropical and semi-tropical regions of the world” (De Foliart, 2002). In many “regions of Zimbabwe, South Africa, Zambia and Nigeria, several households make a fairly decent living from commercialising edible insects’ species” (Chavunduka, 1975; Fasoranti and Ajiboye, 1993; Mbata and Chidumayo, 2003; Adeduntan and Bada, 2004). Nigeria as a nation, is blessed with under-utilised edible insects’ species, majority are collected from forests and pastures by womenfolk and kids, treated and consumed or hawked on school locations and markets. The variegated grasshoppers (*Zonocerus variegatus*) (Linn.) (Orthoptera: Pyrgomorphidae) are frequently consumed by “some people in South Eastern Nigeria and some parts of Benue State whereas grubs of the palm weevil, *Rhynchophorus phoenicis* Fabr.

(Coleoptera: Curculionidae), are consumed in many parts of Oyo, Ondo, Osun, Ekiti, Ogun, Lagos (Western Nigeria), Delta and Edo States” (Ekop, Udoh and Akpan, 2010; Elemo, Elemo, Makinde and Erukainure, 2011). ”The larva of *Oryctes monoceros* is eaten in the Niger Delta regions” (Ifie and Emeruwa, 2010). “The population of the *Z. variegatus* is great in the dry season in southwestern Nigeria”, and was reported consumed in the Akoko area of Ondo State (Fasoranti et al., 1993). In various parts of Nigeria the winged termites are known locally by diverse “names such as ‘aku’ in Ibo, ‘chingé’ in Hausa and ‘Esusu’ in Yoruba and are viewed as traditional delicacies” (Fasoranti et al., 1993). “*Macrotermes nigeriensis* and *Macrotermes bellicosus* are relished in all parts of Nigeria, mainly because they exist at the beginning of the wet season when livestock is lean, fresh harvests have not yet formed food, and supply produced from former growing season is running short” (Banjo et al., 2006; Igwe, Ujowundu, Nwaogu, Okwu, 2011). “*Anaphe venata* larvae (African Silkworm) are generally found and eaten in the Western part of Nigeria” (Iwalewa, Onayade, Oyedapo and Daniyan, 2005). “*Cirina forda*, *Bunaea alcinoe*, *Macrotermes natalensis* and *Brachytrupes membranaceus* are all sold and eaten in different parts of Benue State” (Agbidye, Ofuya and Akindele, 2009). “The larvae of *C. forda* are consumed amongst the Yoruba and Nupe people of Kwara and Niger States respectively” (Fasoranti et al., 1993). “The dung beetle, *Aphodius rufipes* has been reported as a traditional delicacy of the Gbagyi people in Niger State” (Paiko, Dauda, Salau and Jacob, 2012). “The caterpillar of *B. alcinoe* is popularly called *Egu* and consumed by the Igbo speaking tribe of eastern and southern part of Nigeria” (Amadi, Ogbalu, Barimala and Pius, 2005; Braide, Sokari, Hart, Nwaoguikpe, 2010b). “The larva of *Lepidoptara litoralia* is common and consumed in the North Central region of Nigeria especially in Plateau State” (Solomon and Prisca, 2012).

Entomophagy is not a concept that is new in many regions of the world. Ants and beetle larvae are consumed by people of different people in Africa also in Australia as part of their sustenance diets. “The popular, crispy-fried locusts and beetles are enjoyed in Thailand and it is projected that entomophagy which the practice of eating insects is commonly practiced by at least 2 billion people globally”. In the literature, more than 1, 900 under-utilised edible insects species have been acknowledged and most of them are found in the tropical areas. “Beetles, caterpillars, bees, wasps, ants, grasshoppers, locusts, crickets, cicadas, leaf and planthoppers, scale insects and true bugs, termites, dragonflies, and flies are under-utilised edible insects species that are regularly consumed” (Arnold et al., 2013).

Forest products for example fuel and charcoal are very significant to the rural dwellers. Others are “various vegetables and fruits, mushroom, under-utilised edible insects (Adeduntan and Bada, 2004; Ashiru, 1988). The non-forest products are necessary for food security, well-being, the social and economic welfare of rural people”. Exploitation of under-utilised edible insects for sale had brought about their extinction in some communities. Improvement of Entomophagy has been proposed by some people for provision of protein in human diets (Fasoranti, et al 1993). Consequently, under-utilised edible insects species are known for their capability to possess a high generative capacity, with small life cycles, does not cost much to get and domesticate. Many other Under-utilised species could also play a key role in traditional medicine. In most cultures across the globe, under-utilised edible insects are traditional food playing a significant role in human diet and have many nutrients to provide for the body. Entomophagy has “a long history of many cultures and more than a thousand insect species are edible at some phase of their cycle. These under-utilised edible insects can be raised for their great dietary potentials and traded to the masses that regards them as food. In some areas of Zimbabwe, South Africa, Zambia and Nigeria, many households make a fairly decent living

from commercializing edible insects. These edible insects are both sources of food and revenue for the rural poor and these food sources will remain to be tapped widely by people in the third world” (De Foliart, 2002, 1990; Latham, 2001). Trends just before 2050 forecast a stable population growth to 9 billion persons and feeding this population will mount pressure on existing agro-ecosystems as a result of an increased food/feed output. Dearth of farmland, sea, woodland, fishery and bio-diversity resources, including nutrients as well as non-renewable energy, are forecasted.

Under-utilised edible insects comprise nutrients like protein of high quality, vitamins as well as amino acids for human consumption.

1.2 Edible Insects in Nigeria

Although, insects have been termed to be destructive and have suffered rejection due to the fact that it irritates some people’s gut. However, there are still several insects that are pleasing to the gut with desirable taste, nutritious value and since inception, people in many cultures across the globe delight in consuming edible insects.

Edible insects are consumed across the country in Nigeria. Edible insects are consumed to wet the cramps of starvation, and sometimes as snacks by poverty affected families, street and urban slums children. Adults, however, consumed edible insects as food or as a leisure. The insects normally consumed in Nigeria are:

- **The Termite:** Well-known as” **esunsun** in Yoruba and **shinge** in Hausa”. Flying termites are usually eaten in Nigeria and are a delicacy in the Delta North Senatorial zone of Delta State (Ivbijaro, 2003). They are generally consumed in Ondo State (Ajayi and Adedire, 2007). Termites are the most plentiful food insect in Benue State (Agbidye et al., 2009).

- **Caterpillars** are “the larvae of butterflies and moths”. The grubs of the African silkworm (moth) *Anaphe venata* are regularly consumed roasted in southern Nigeria. Called **Ekuku** in Yoruba, the larvae are very well eaten in Ondo State (Ashiru 1988; Adeduntan et al., 2004). They are prepared by frying or exposure to air in hot, white soil.
- The “**Larvae (Caterpillars) of the Giant Silkworm, *Cirina forda***”, recognized in Hausa as “**Manimani**, and in Yoruba as **Kanni**, the larvae (caterpillars) of the giant silkworm, *Cirina forda* are also named the pallid emperor moth or the saturniid caterpillars. The giant larvae are the most extensively marketed food insects in Kwara State” (Fasoranti et al., 1993). “The larvae are starved for one or two days after gathering to remove their gut content, then cooked and dried over mats on the earth”.
- **Crickets:** This common cricket, “*Brachytrupes membranaceus* is consumed across Nigeria. Known in Hausa as **Gyare**, and in Yoruba as **Ire**, the cricket is generally hunted by children and farmers who empty water into its hole on the ground to choke it and the cricket appears wildly from the hole into the hands of their predators. Crickets are usually heated and are quite enjoyable to taste”.
- **Grasshoppers:** “The variegated grasshopper, *Zonocerus variegatus* L. is consumed and enjoyed across Nigeria particularly in the South West, and Kwara”, (Ademola, Idowu and Olatunde, 2004); “in the South-south, especially Akwa Ibom State (Ekop et al, 2010), and in Samaru, Zaria” (Mba and Elekima, 2007).
- **The Short-horned Grasshopper:** “*Cytacanthacris aeruginosus unicolor* is a different kind of grasshopper that is generally eaten all over Kwara and Niger States” (Banjo et al., 2006)
- **The Palm Weevil and the Rhinoceros beetle:** “Larvae of the palm weevil, *Rhychophorus phoenicis* (F) and of the Rhinoceros beetle, *Oryctes monoceros* Oliver are very well

consumed in the tropical rain forest, riverine and coastal states where the oil palm is grown. Fixed on thin bamboo sticks or on other flat and slim sticks of about 30cm long, the larvae of both beetles are heated or deep-fried to taste and eaten with *Foniyan*, a type of tapioca or with bread. Both larvae are very well spread in Delta and Ondo states”.

- **The Honey Bee, (*Apis mellifera*):** The mature “honey bee is hardly eaten in Nigeria. It has a tough cuticle (exterior) and sturdy, piercing mouth parts. The eggs, grubs, and pupae are however, reported consumed in some parts of the country”.

1.3 Statement of the Research Problem.

The use of Under-utilised species (US) is increasing and is being known as a vital component of diet and livelihood in many regions of the world yet these resources are not fully utilized by many that are in dire need of them. Edible insects as a typical US have potentials in the fight against hunger and malnutrition because they are high in protein, vitamins, as well as minerals and unsaturated fats. However, these insects are not harvested and processed in commercial quantity. Presently, the cost of conventional animal protein is on the increase due to economic recession and one of the cheap source of protein and of course a perfect substitute is edible insect. Looking at the ongoing economic recession in Nigeria, where malnutrition in children and hunger in adults is on the increase due to the shortage of food and a hike in food stuff prices, expanding the level of commercialization of these insects could be the answer and key to fighting hunger, protein deficiency and malnutrition. In addition, the extra cash generated from the sales of these insects could have a progressive effect on the livelihood status of the farmers. From literature, many have focused their attention to the importance of US in improving diet, generating revenue, preserving environment, wellbeing and empowering the poor and marginalized, as well as in supporting cultural diversity and despite the growing body of

scientific literature on US and an emerging set of case studies, no research has considered Edible Insects as a typical example of US. It is not also too clear in the literature the extent at which farmers' livelihood is impacted from the sales of the edible insects. The nutritive and economic value of edible insects is of great significance, therefore there is a need to embark on empirical research that provides relevant information on insects' commercialization in the rural settings. Hence, this research intends to fill this gap in knowledge by providing responses to the subsequent research questions:

1. Are there edible insects in the study area?
2. What is the level of commercialization of underutilized edible insects?
3. What factors affect the level of commercialization of edible insects?
4. Are there returns to edible insects' commercialization?
5. Does edible insects' commercialization contribute to the livelihood status of rural households in the study area?

1.4 Objectives of the Study

The broad objective of this study is to examine the commercialization of Underutilized Edible Insects among rural households in the study area. The specific objectives are to:

- i. enumerate various edible insects in the study area;
- ii. determine the level of commercialization among rural households;
- iii. examine factors affecting the level of commercialization of edible insects;
- iv. evaluate returns to edible insects' commercialization;
- v. determine the contribution of edible insects' commercialization on the livelihood of rural households.

1.5 Justification for the Study

Increasing food production is necessary in feeding the vast rising world population. Achieving this might place substantial burden on the already “existing inadequate resources such as land, oceans, fertilizers, water and energy” (FAO, 2012). There is bound to be upsurge in GHG emissions, deforestation and environmental degradation if agriculture remain in its existing form. These ecological hitches, especially those related with raising livestock require crucial attention as compared to under-utilised edible insects which discharge moderately few GHGS and relatively minute ammonia. “Meat and fish are essential sources of protein in many countries”. According to Mathew (2006), altogether, “rearing of livestock occupies about 70% of agricultural land. Between 2000 and 2050, universal request for livestock products is likely to increase by two ranging from 229 million tonnes to 465 million tonnes and meeting this request requires inventive answers”. Likewise, production and consumption of fish have increased intensely in the past five years. As a result, the aquaculture segment has thrived and currently accounts for almost 50 percent of global fish production. For aquaculture sector to attain a sustainable growth it will rest solely “on the supply of earthly and marine plant-based proteins for feed. The prospect for under-utilised edible insects species to help meet increasing demand for meat products and substitute fishmeal and fish oil is vast since edible insects are considered delicacies in various parts of the world, especially in the tropical regions”. Under-utilised edible insects possess excellent protein and nutrients comparable to beef and fish products. Under-utilised edible insects are essential “food supplement for malnourished children because most under-utilised edible insect species are high in fatty acids as compared to fish. They also contain fiber and micronutrients such as copper, iron, magnesium, manganese, phosphorous, selenium and zinc” (Arnold et al., 2013).

In recent time, our poor economy has called for a shift in attention from total reliance on administrative jobs to discovering ways of self-employment, raising under-utilised edible insect

could be one of the ways. Insects rearing involves little time and does not require much in terms of capital, it is easy to learn, and a fast income producer. The nutritional value of insects needs to be taken into consideration when addressing food safety and poverty mitigation policies in Nigeria.

Insects are regarded as nuisance by a great number of individuals, regardless of the growing literature indicating their valuable role in the nutrition of man and animals. This research will help in revealing ways of reducing hidden hunger and protein deficiency that are affecting households. Processing of these edible insects might help improving farmers' livelihood, bring about increased income and lower unemployment. In addition, the study will help in informing policy makers about the relevance of insects' commercialization.

1.6 Organization of the Study

The residual part of this thesis includes chapter two, three, four and five. Chapter two presents the literature review where the empirical, theoretical and conceptual framework are presented. Chapter three give the description the methodology that the study adopted. This includes the description of the study area, the method of data collection, survey and sampling procedures and the analytical techniques used. The results and major findings are presented in Chapter four. Finally, chapter five presents the summary of the study, conclusions deduced from the study and recommendations for improvement and policy making.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

2.1.1 Theory of Agricultural Commercialization and Market Participation

The theoretical foundations for analysing economic behaviour of rural smallholder farm household with respect to market participation, input intensification and resource allocations are vast and varied. For example, Boserup (1965) showed that land constraints can create positive pressures to intensify agricultural production. Furthermore, Boserup, opined that “population pressure is a major cause of change in land use, agricultural technology, land tenure system and settlement forms”. It was disputed that the major means of developing agricultural production is intensification. However, “according to this theory, intensification does not involve better use of capital and labour to each unit of farmland rather it involves more frequent cropping of the total area available”. Since this study is on insects, frequent harvesting of edible insects of the total area available could bring about increased agricultural production.

In Boserup’s view, “little of the entire area is harvested when population densities are low, and farmland which has been used at least for two years is left to relapse to long periods of natural fallow; however as population density increases the period under crops” go up thereby shortening the duration of fallow. In the last phase, fallow will still occur but with only one crop grown on each component of farmland in a year. Though, the aggregate yield rises as the frequency of harvesting increases, hence yield per head drops. In the literature on agricultural intensification, while factors such as population pressure and market demand remain important for explaining agricultural intensification, several other empirical studies have discovered the role of “environment, gender, social capital, household composition, tenure, off-farm employment opportunities, ethnicity, and state policies such as the Green Revolution” (Turner and Fischer-Kowalski, 2010).

No doubt, the Boserup theory remains important in agricultural development theory. However, it has been criticised on some grounds. For example, Grigg (1979) argued that the theory seems “to be narrowed to pre-industrial societies and ignores farmers who (i) use inorganic fertiliser,

(ii) are profit maximisers, and (iii) use labour-saving machinery. Also, the theory neglected the possibility of increasing output through the acceptance of high yielding varieties. The central argument of the Boserup theory is that population pressure is the only cause of intensification or that the increased frequency of harvesting is the single answer to population pressure”.

There is a clear distinction between “market-driven growth model and the Boserupian population pressure-driven growth model”. Market-driven growth model is characterised by favourable “market conditions that could quicken the fusion of new farmland for production and fast-track intensification, introducing thorough use of chemical inputs with high yielding varieties even in low population density areas”. This difference was aptly described by Goldman (1993) and Smith, Barau, Goldman and Mareck (1994) who distinguished “between population-driven intensification based on Boserupian reactions to population pressure and market-driven intensification”.

2.1.2 Theories of Agricultural Transformation

Another theory that has advanced in the agricultural commercialization literature is the theories of agricultural transformation by Johnston and Mellor (1961) which derives from the dual economy model which draws a clear variance “between the traditional and modern sectors of the economy”, usually characterised as agricultural science and manufacturing industry, respectively. At the macroeconomics levels, agricultural transformation involves four quite relentless and interrelated process : (1) a decreasing segment of agriculture in Gross Domestic Product (GDP) and employment, (2) the fast process of urbanisation as people move from rural area to urban regions, (3) the increase of a modern manufacturing and service economy, and (4) a demographic switch from high to low rates of childbirths and demises” (Timmer, 1998). In addition to this transformation process and at the household level, the economy switched “from

subsistence-oriented household-level agricultural production toward a unified production and exchange scheme centred on higher concentration and market transactions (commercialization), while taking into consideration economies of scale” (Johnston et al 1961; Lewis, 1955).

A key feature of “agricultural transformation in the course of economic development is the switching of smallholder farming from subsistence to more commercialised enterprises” (Johnston *et al.*, 1961; Johnston, 1970). Rural farm households through agricultural commercialization progressively partake in the market economy to make higher earnings, gather assets, and be elevated “out of poverty and food insecurity as the process of structural transformation forms root” (Jayne, Minde, and Argwings-Kodhek, 2002; Gabre-Madhin and Haggblade, 2004; Haggblade, Hazell and Reardon, 2010). “An integral part of the agricultural transformation process is the adoption of agricultural technology, leading to increase on-farm production and productivity and thus better reliance on the market for farm inputs, outputs, and services, which are all essential for diversification and specialisation to take place” (Chapoto, Mabiso and Bonsu, 2013). Clearly, theories of agricultural transformation are an improvement over Boserup, it still does not capture the array of market failures that are idiosyncratic and are important in explaining behaviour of agricultural households.

It is well recognised that, in the context of developing countries such as in Nigeria, rural farming households are steadily opened to market inadequacies and restrictions called to as “failures” and one cannot understand their conduct without referring to “the specificity of these failures” (Thorbecke, 1993). Thus, “for rural households conduct to be model in the context of market failures it means that both production and consumption decisions cannot be a separate entity. In this case, production and consumption decisions are unified and conventional microeconomic theory is no longer appropriate to model farm household conduct. Consequently, farm household models have been developed that directly integrate the

interdependency of production and consumption decisions". This model (non-separable) was first presented in Singh et al.'s, (1986) seminal book.

As long as perfect input and output markets exist, there is only a one-way link from production to consumption. As households can buy and sell commodities at the market price, their consumption decisions will not influence the level and composition of their output. Similarly, as labour can be freely procured and traded in the market, the amount of labour households used in production depends neither on the endowment of household labor nor the decision of the household to allocate family labour between work and leisure. In this situation, the farm household's objective can reasonably be taken as profit maximisation.

However, as noted earlier, rural sectors in developing countries such as the Savannah of Nigeria are characterised by imperfections in input and output markets and credit and liquidity constraints. The imperfection of output market, for example, means that edible insects' households can only consume their own edible insects output (when the good is not traded) or they choose to consume self-produced good to market-purchased good (because of high transaction cost). By consuming all or part of its own output (in this case, edible insects) which could otherwise be traded at a given market price, rural households that commercialise under-utilised edible insects indirectly buy things from themselves. By demanding rest or allotting its time to family production events, it indirectly purchases time, treasured at the market remuneration, from itself. For this situation, farm earnings comprise inherent earnings from goods created and eaten by the same household. Likewise, household decisions on the allocation of labour influence its production decisions. Since labour markets are thin, a decision by the household to consume more leisure means less labour for edible insects processing and hence a decline in production. Rural households also largely depend on their own sources for other non-labour resources as they have no or little access to credit. Thus, the proposition that profit

maximisation is the main objective of the rural household does not hold; rather, the objective is utility maximisation.

These models of agricultural household were first presented to clarify the counter spontaneous empirical discovery that a rise in price of crops did not meaningfully increase the marketed excesses in agricultural sector. Following this early emphasis on farm price policy, there have been some theoretical advancements. The use of the theory has been expanded to include off-farm labour supply, technology policy, fertiliser intensification, and more recently agricultural commercialization or market participation under transaction cost, liquidity constraint, risk aversion and present bias (Ricardo, Reardon and Guan, 2010; Tzouvelekas 2011; Holden & Lunduka, 2013).

In its role acting as both “producer and consumer, the family makes decisions on production, labour allocation and consumption that may be dependent upon one another. In its most general imaginable form, the household’s objective is to maximise or derive satisfaction from a list of consumption goods including home-made goods, procured goods, and relaxation, subject to some set of constraints. These constraints usually include: cash income, family time and gifts of fixed productive assets, and production technologies. Consequently, price-related constraints also fix prices exogenously as in the case of surpluses that are marketable or in the case of missing markets that stipulate an internal “shadow price” determination condition, i.e., the household’s request for a good equal its output” (the case of household non-tradables with missing markets; Strauss, 1986; de Janvry, Fafchamps & Sadoulet, 1991).

Providing solution to this “farm-household model requires a set of basic equations for production, inputs demands, consumption demands as well as prices for household non-tradable and or marketed excess for household tradable”. In case of collected edible insects, the surplus which is to be marketed is subtracted from the ones the household will consume.

Generally, the theory of household model is used to clarify the economic behaviour of: (1) “the net-surplus producing household farm, typical of small owner-operated farms of medium productivity; (2) Household farm that are into subsistence and sub-subsistence production, characterised by small-scale, low output agriculture, commonly operating under marginal conditions and incomplete markets; (3) small-scale leaseholder and sharecropper farms; and (4) commercially owned operated farms producing both food for home consumption, agro-industry and export markets. These situation describe the agricultural systems in which most of the rural population in the developing world” are involved including farmers in the Savannah of Nigeria.

From the foregoing, both case 1 and 2 were applicable to the context of the study. According to Pender and Alemu (2007), theoretical model of “smallholder commercialization of food production: the models of Key, Sadoulet, and de Janvry (2000); and Renkow, Hallstrom and Karanja (2004), show that operation costs have impact on the household market participation regime. The incentive to employ labour and other variable inputs in food production depends upon what marketing system the household uses. The variances in access to technology and resources are essential reasons for variances in marketing system; but such differences in system choice may also arise from differences” in family request situations for example household size and composition”.

This study therefore adopted both theory of agricultural commercialization and market participation, and agricultural transformation. This is because when insects commercialization is intensified, it will bring about increased livelihood. So also, if insects are not only produced at subsistence level but at commercial level, farmers would be able to take part in the market. Participation in the market will therefore help the farmers to sell their surpluses thereby

generating higher earnings that would help make the rural households have higher living standard which will therefore promote economic development.

2.2 NUS and Food Security

- Many “NUS have the prospective to add to food security at indigenous and district levels. In a progressively globalized and inter-reliant world, eliminating food shortage is a requirement for harmony and world security. We need to diversify more in agricultural and food schemes if we are to provide food for population of 9,000million come 2050 in a more sustainable way, while at the same time guarding the environs, providing vigorous and wholesome food for all, and improving the livelihoods of farmers. Nationwide, NUS can fortify a country’s food and cushion the effect of economic and social shocks that might hit the population as a consequence of focusing on less species. Regularly acknowledged as ‘Famine Food’, farmers have gone back to and have depended on NUS throughout history each time major staple crops have failed. NUS can also offer a protection in times of stress and follow calamities and other crises. This was proven in several Asian nations following the Tsunami and West Africa and other areas following the war and civil conflict” (Arnold et al., 2013).

2.3 NUS and Diet.

- In era of Green Revolution and the years that preceded, the effort of researchers was to increase farm yields so as to safeguard sufficient calories for individuals that may be suffering from hunger. However, little consideration was given to nutritious food. The focus was more on adequate measure rather than on healthy food. As a result, food that people consume in many parts of the world are deficient in essential vitamins and micro-nutrients. “Of the world’s projected 7,000 million people, about 500 million people still suffer from

protein-energy malnutrition, however, over 1,600 million people suffer from iron deficiency, over 200 million people from vitamin A deficiency” (WHO, 2008, 2009) “and over 400,000 children die due to zinc deficiency each year” (HarvestPlus, 2011). Under-utilized crops contain necessary micro-nutrients and hence complement main diets. In addition, Neglected and Under-utilised species add flavor to local cuisine, fortify local cooking traditions and generate revenue for both the rural and urban poor. Several “NUS are rich in carotenoids and minerals and could play an important part in improving the micro-nutrient content in the diets of many people around the world”. (Arnold et al., 2013).

2.4 Contribution of Under-utilised edible Insects

- Under-utilised edible insects have contributed immensely to our health, environments as well as our livelihood. For instance, **on health**, edible insects have acted as a supplementary food to malnourished children mainly because they are high in fatty acids. They also give micronutrients like “copper, iron, magnesium, manganese, phosphorous, selenium and zinc” (Arnold et al., 2013). Ability to transmit zoonotic diseases is also low in insects (infections communicated from animals to man) such as H1N1 (Swine flu), H5N1 (Avian flu) and Bovine Spongiform Encephalopathy (mad cow disease).

On Environment

- The greenhouse gasses produced by edible insects is lower than those of ruminant animals like cattle. For instance, “pigs produce 10–100 times more greenhouse gasses per kg of weight than mealworms. Insects can eat food and human waste (bio-waste), compost and animal slurry, and therefore can convert these bio-waste into a high-quality protein which can later be used for feeding animals. Farming of insects requires little land area and uses less water compared to livestock. For instance, mealworms are more drought-resistant than

cattle. Insects are cold blooded animal and thus can convert feed efficiently. On the average, insects can change 2 kg of feed into 1 kg of insect mass, while cattle require 8 kg of feed to produce 1 kg of body weight gain” (Arnold et al 2013).

- **On Livelihood**

Collecting and raising insects can be a means of livelihood diversification. They can be collected easily from the wild. It requires low technical experts and little capital to procure instruments for rearing and harvesting them. Edible insects can be assembled, raised, processed and marketed by women and the landless in both urban and rural area. Through selling of the surpluses as highway food by the rural poor can directly enhance their livelihood and also improve their diets. Gathering and cultivation of edible insects can provide an entrepreneurial opportunity for people in the developed, transitional and developing economies.

2.5 Concepts of livelihood

A livelihood includes the abilities, possessions such as “stores, resources, claims and access and actions necessary for a means of existing. For a livelihood to be sustainable, it must be able to deal with pressure and shocks and recover from both and as result improve its abilities and possessions both at the present and in the future while the natural reserve are not undermined” (Chambers and Conway, 1991). Frankenberger and Curt, (1994) defined livelihood “as the sustainable satisfaction of elementary desires which consist of sufficient access to food, shelter, clothing, portable water, health facilities, educational opportunities, time for community involvement and social integration among many others”. It is usually a measure of the quality and size of goods and services used by the farmer and his household such as expenditure on consumable goods, fixed assets acquired, children in school and other services such as

healthcare, portable water, good shelter etc (Taimi, 2003). It is a satisfactory stock flow of the food and exchange means to individual or a group of people to meet its elementary needs. It transcends the general meaning of being how a person acquires money to make a living. It also includes everything done to obtain a living (Rahman, Frdissa, Bwaya, Lund and Ghulan, 2007). It puts into consideration the proficiencies, assets (natural, physical, human, financial, political and social capital) and actions necessary to make a living. Livelihood security therefore means protected rights of individual, or access to capitals and revenue producing activities, plus resources and assets to counterbalance threats, comfort shocks and meet contingencies. Both men and women in the rural area particularly those from poor families, involve themselves in various and numerous activities (farm or off-farm) to increase their livelihoods by taking full advantage of revenue producing activities while reducing susceptibility and threat, and achieving other house hold goals (better-quality health, nutrition and education etc). The major ways of getting livelihoods by the rural households has been classified into four.

These are:

- Production-based livelihood:

Making availability and accessibility to inputs and better systems (technologies/modernization/intervention) of production are reasonably serious for their livelihoods. They constitute the farm families who are either subsistence or commercial in their practices.

- Labour-based livelihood:

Mostly a characteristic of small landowners and landless rural families who make a living by selling their labor. Salary and prices of food are most critical in this respect.

- Exchange based livelihoods:

It comprises of those that sell their surpluses or that of other farmers as well as non-agricultural products to earn a living. The marketing scheme aimed at these goods and relative prices of what is being traded and what is being purchased, disturb their livelihoods.

- Transfer-based entitlements livelihood:

The rural families that has no revenue earning asset or families without any income-producing asset or capable individual to work rely on government or other social organizations for their livelihoods.

2.6 Major Orders of Edible Insects

Worldwide, “the most common insects eaten are beetles (Coleoptera) (31 percent). The consumption of caterpillars (Lepidoptera), which is particularly famous in sub-Saharan Africa is estimated at 18 percent. Bees, wasps and ants (Hymenoptera) come third at 14 percent (these insects are common in Latin America). Next are grasshoppers, locusts and crickets (Orthoptera) (13 percent); cicadas, leafhoppers, planthoppers, scale insects and true bugs (Hemiptera) (10 percent); termites (Blattodea) (3 percent); dragonflies (Odonata) (3 percent); flies (Diptera) (2 percent); and other orders (5 percent). Lepidoptera is eaten virtually completely as caterpillars and Hymenoptera are eaten mostly in their larval or pupal stages. Adults and larvae of the Coleoptera order are consumed, while the Orthoptera, Homoptera, Blattodea and Hemiptera orders are virtually consumed in the developed phase” (Cerritos, 2009).

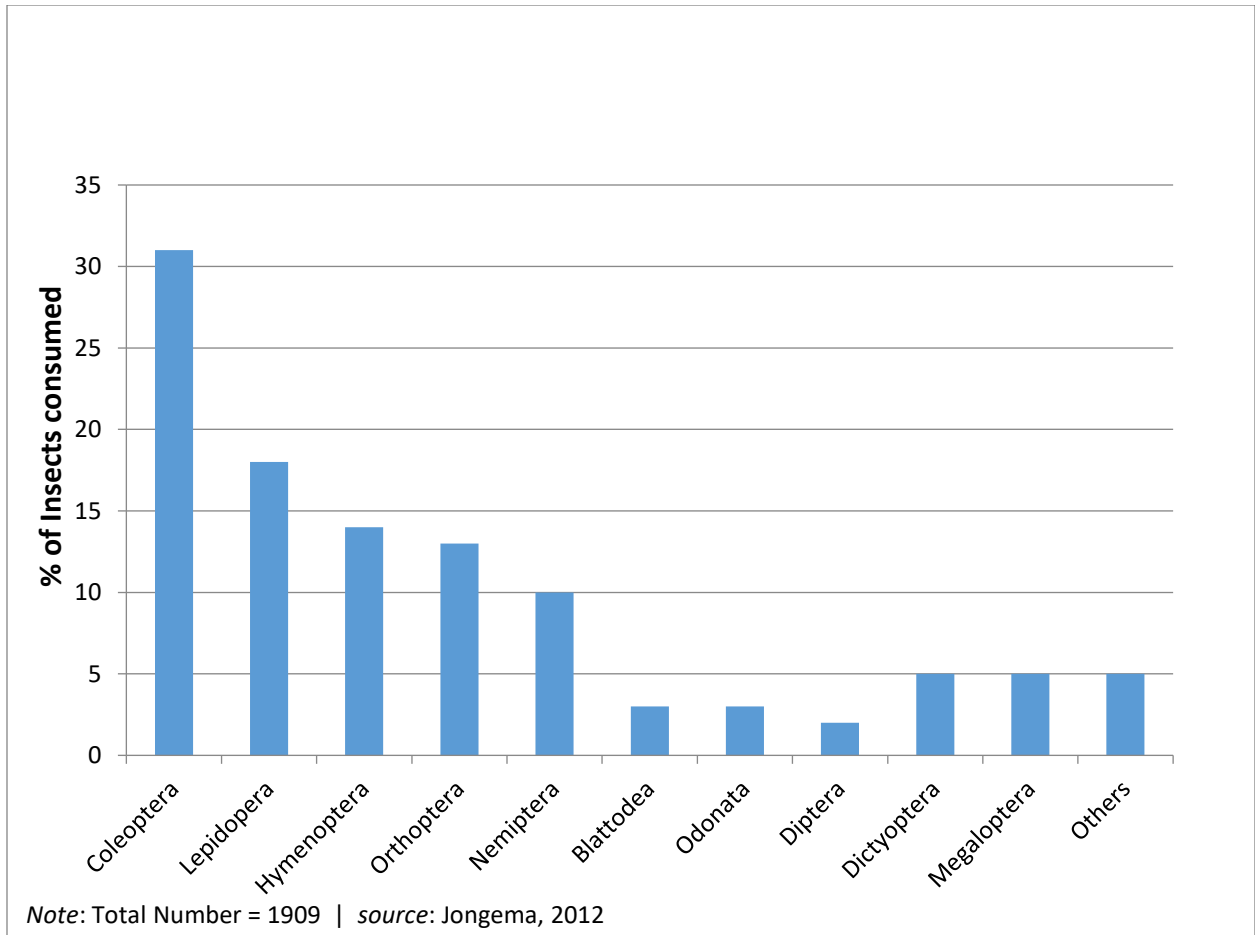


Figure 1: Number of insects by order, consumed worldwide.

2.7 Edible Insects as an Engine for Improving Livelihood

The poor in the rural areas make a reasonable living from forests and trees as these generate food and revenue for them. Of the world’s poorest people which is estimated to be 350 million together with 60 million local people rely on wooded areas for their day-to-day “subsistence and long-term survival” (FAO, 2012a). “Edible insects are a main source of livestock protein

in many areas and are important for diet diversification but, in most countries, consumption of edible insects is not a thing of existence but a question of individual choice. Indeed, the majority of edible insect consumption is by selection, not something that's of necessity, besides edible insects are a part of indigenous belief. However, insects do offer cherished buffers against periodic scarcities of food" (Dufour, 1987). In addition to this they act as essential food stuffs, edible insects offer extra money for basic expenses, as well as on food, agricultural inputs and training (Agea, Biryomumaisho, Buyinza, and Nabanoga, 2008; Hope, Frost, Gardiner, Ghazoul, 2009).

"Trade in edible insects is a main source of earnings in certain areas and what is gathered is not at all times completely eaten directly by the gatherers themselves. Edible insects provide key livelihood opportunities for a lot of people in developing countries, as well as some women and children particularly the poorest sections of the world. In a post-Rio+20 context, the social, economic and regional irregularities and disparities that still prevail in various parts of the world could be solved through greening the economy with forest products like edible insects" (FAO, 2012b).

2.8. Insects as Fragment of the Mini -livestock sector

"The mini-livestock sector is key in generating returns and livelihoods for people all over the world and this accounts for 40 percent of agriculture's overall GDP" (Steinfeld, Gerber, Wassenaar, Castel, Rosales and Haan, 2006). Nevertheless, even with the increasing demand for livestock products, animal such as pigs, goats and chickens are frequently not seen as important. Nevertheless, "mini-livestock such as edible insects can be significant for economic diversification. Edible insect cultivation can be carried out both in urban, peri-urban and rural areas and is an effective use of space" (Oonincx and de Boer, 2012). Even though some efforts "have been made to tame some certain edible insects, majority of these species, for example,

tarantulas, can only be harvested in the wild” (Munke, personal communication, 2014). Mini-livestock businesses are beneficial because they need “small space, do not compete with human for food, have higher demand than their supply, generate more revenue within a short period of time, possess high reproductive rates; are nourishing and are included into human diet; transform feed to protein efficiently; quite simple to manage; easily moveable; often easy to raise and do not involve comprehensive training” (FAO, 2011b):

Edible insects, “with other mini-livestock, provide backing to market diversification since they can be retailed to users both in the rural and urban sectors. In most cases, rural dwellers will trade their mini-livestock within their settlements; although, edible insects can easily be transported to urban markets by bus, cars, wheelbarrow, truck or bicycle. Raising edible insects can also be done as a complement to other livelihood schemes. Furthermore, raising edible insects can be done by landowners and the landless respectively (FAO, 2011b) because little space is required. For most families, a constant income flow stimulates savings and the capability to pay intermittent expenditures such as school fees” (FAO, 2011b). However, “gathering of edible insects from the wild should not be considered as irrelevant because it can similarly add to livelihood diversification. In some provinces of Africa, for instance, the consumption of edible insects has been projected to vary between 2 percent and 30 percent of overall meat consumption in a year, subject to the availability of edible insects”(FAO/WUR, 2012). In most cases, raising mini-livestock do not require much resource; thus, it can be practiced by the poorest people in the rural areas “particularly the women, men, the elderly and even children. Raising and gathering of edible insects both in the wild and in domestication requires a small initial capital followed by incremental investments, which can decrease economic threat. Other resources needed for rearing edible insects include nets, plastic sheets and containers (Hanboonsong, 2010). Therefore, rearing and harvesting edible insects can

positively add to economic development and growth, particularly for the poorest groups, for instance, the landless”.

2.9. Improving Local Diets

Majority of the edible insects harvested by rural households are meant for family consumption; however, this is determined by locality and type. “Surpluses are possibly sold in indigenous and regional markets. In Papua, Indonesia, for instance, local communities eat between 60 and 100 edible insect species in order to diversify their nutritional requirements. The excess is sold in markets, such as the black palm weevil (*Rhynchophorus bilineatus*), which is harvested from the sago palm (*Metroxylon sagu*). Palm weevils are the most regularly eaten edible insect species in the region. The cost of one bag containing 100–120 larvae makes US\$2.11 in indigenous markets, comparable in worth with 20 chicken eggs and 3 kg of rice” (Ramandey and Mastrigt, 2010). Nevertheless, “some edible insects are harvested more for profitmaking than for family consumption”.

Though “edible insects are commonly eaten for their taste, they can also give food in times of scarcity. However, it should be stressed that eating of edible insects as a source of emergency food is not the major reason for their consumption”. A study carried out in Kinshasa in 2003 stated “that 70 percent of the city’s population eats mopane caterpillars because of their dietary value and palatability”.

Nevertheless, in time of scarcity of other protein sources, “edible insects are an essential part of the diet. In the Central African Republic, 95 percent of those that reside in the forest rely on consuming edible insects to get their protein” (FAO, 2004). Sometimes, “edible insects are the only source of essential proteins (amino acids), fats, vitamins and minerals for rural people. In

many parts of the world, Eating of edible insects is periodic for dual reasons in most parts of the world: indigenous people feed on seasonally existing plants, and the excess is not put in storage due to a shortage of processing and preservation techniques. In West and Central Africa, including parts of the Amazon, there is scarcity of bushmeat and fish during the wet season, and it is during this wet season that eating of edible insect rises significantly. Edible insects tend to be more plentiful during the wet season, when they constitute valuable parts of indigenous diets and offer important nutrients” (FAO, 2004).

2.10. Processing of Under-utilised Edible Insects for Food and Feedstuff

Edible insects after being collected from the wild are processed into different kinds of consumables.

2.10.1. Different Kinds of Consumable Products

Edible “insects are killed by boiling, frying, roasting, freeze-drying or sun-drying or boiling. Processing and its consumption can be in three ways: they can be “consumed as whole insects, can also be processed into ground or paste form, and lastly its protein, fat or chitin can be extracted to fortify food and feedstuff.

In nations where edible insects are eaten by tradition, food lifestyles have moved towards Western diets. Inventiveness have been carried out to counter this, for instance, in Mexico, where tortillas are being enhanced with yellow mealworm” (Aguilar-Miranda, Lopez, Escamila- Santana and Barba de la Rosa”, 2002).

2.10.2 Whole insects

“Edible insects are regularly consumed whole in tropical region, but then some edible insect, require the removal of body parts for example grasshoppers and locusts (such as wings and legs). Fresh edible insects can further be processed by roasting, frying or boiling depending on the dish. In the Lao People’s Democratic Republic, amongst other republics, insects can be seen

in markets as ready-to-eat snacks. Some edible insects are fried with lime leaves” (Arnold et al., 2013).

2.10.3 Granulated or paste form

A common technique for “processing a bulky variety of foods is by grinding. For instance, Soybeans are often changed into tofu or other meat products. Meat, for example, is processed into hamburgers and hot dogs, while fish fingers are products of fish. In the same manner also, edible insects can be transformed into more tasty forms. They are ground into paste or concentrate and are added to food that are considered to be low in protein so as to raise their nutritional worth. Drying and crushing the insects is a cool way of obtaining the powdery form of edible insects. In cultures where consumers are not familiar to consuming whole insects, granulated or paste forms may be well accepted” (Arnold et al., 2013).

2.11 Extracted insect proteins

Western buyers may be unwilling to take edible insects as an authentic “protein source because edible insects at no time played a significant role in their food culture. Insect protein which is extracted for human consumption though a technique being already carried out “could be a convenient means of raising its acceptability among cautious consumers. In certain cases, removing insect protein is necessary to increase the protein content of a food product”. Nevertheless, augmenting food products with edible insects requires wide knowledge of the properties of the extracted proteins. These properties include, among others, amino acid profile, thermal stability, solubility, gelling, foaming and emulsifying capacity” (Arnold et al 2013). According to Arnold et al (2013) “separating extracted protein groups based on their solubility in solvents produces water-soluble and water-insoluble fractions, which can be used for specific

applications in both the food and feed industries. Alternative methods are enzymatic processes to obtain proteins of specific chain lengths. Alternative methods for protein separation are fluidized bed chromatography and ultrafiltration. At present, the cost of protein extraction is prohibitive". Additional research is needed to further improve the technique and to render it lucrative and applicable for industrial use (Arnold et al., 2013).

2.12 Food Safety and Preservation

The three closely related terms are food safety, food processing and food preservation. "Edible insects, like several meat products, are high in nutrients and moisture, enabling a favourable environment for microbial existence and growth" (Klunder, Wolkers-Rooijackers, Korpela and Nout, 2012). Local processing techniques, for instance "boiling, roasting, and frying, are regularly applied to increase the taste and palatability of edible insects and have the added benefit of guaranteeing a harmless food product. Racial preferences and organoleptic (sensory) features play important roles in selecting conservation techniques. Though an extensive variety of modern conservation technique is available, exact measures to ensure a good and harmless food item may be needed for different insect species, depending on their genetic makeup. Determining ideal preservation techniques will be a critical issue in the commercialization of under-utilised edible insects on an international scale, be it for food or feedstuff".

"The Hazard Analysis Critical Control Points (HACCP) system, a knowledge-based and logical tool, pinpoints specific dangers and institutes control systems to ensure the security of food" (FAO/WHO, 2001). It concentrates more on prevention than depending "mainly on end-product testing. HACCP is known globally as a system for quality assurance, recognizing, evaluating and regulating physical, chemical and biological hazards during the course of production. Starting from primary production to final consumption the application of the system can be

done. In addition, it increases food safety. The application of HACCP can also assist assessment by regulatory authorities and promote global trade by growing confidence in food safety. For edible insect sector to continue to success and develop the adoption of HACCP throughout the insect supply chain would be required”. According to FAO, “any HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological development” (FAO/IAEA, 2001).

Although it has been noted that “no important health issues have risen from the eating of edible insects (Banjo et al., 2006), consumer self-confidence is debatably strongly linked with the perceived safety of a given product. In this vein, the use of insecticides on insects meant for food sector raises vital issues, both for nutritional safety and involvement in the international market”. It is well documented that species trapped in fields, for instance, “are more likely to contain insecticides or heavy metals than those harvested in thick forests. Chapulines (*Sphenarium purpurascens*) – red grasshoppers typically collected in regions like Oaxaca, Mexico – have been found to have high applications of lead from neighboring mines” (Handley, 2007). Several countries in Africa do not have rules governing the use of chemical substances in fields in areas where village dwellers harvest edible insects. Most of the time, “the gathering takes place with the little awareness of the consequences that consuming chemically treated insects might have” (Ayieko, Kinyuru, Ndong’a and Kenji, 2012). “However, food-safety concerns are significant not only for edible insects harvested in the wild but also for cultivated insects”.

2.13 Summary of Edible Insects in Nigeria

“Of all nations in the coast of West Africa and to the east Chad, Sudan, Ethiopia, Somalia and countries North Africa, Nigeria is the best studied country as insect for food is concerned. Other

nations on the southern coast of West Africa perhaps own edible insects that might be comparable to what is available in Nigeria, but then fewer information is present. In the north of the coastal countries, the variety is highly reduced, with locusts being the only species, and mostly the forest locust, *Schistocerca gregaria*. Edible Insects of at least 25 species are consumed, belonging to at least 21 genera, 13 families, and 7 orders” (Ene 1963) .

Research in Nigeria reveal that most Nigerians have in one way or the other had direct or indirect involvement with consumption of edible insects, although it is more predominant in rural areas than the urban areas. In some other parts of Africa, the more you get educated, the more reluctant to accept that native cultures are still in existence, as well as consumption of edible insects. However, researchers of today, for example, Fasoranti et al., (1993), believe that promoting consumption of edible insects through education can help meaningfully in decreasing lack of protein in the country. Development of mass raising techniques, instead of always relying on harvesting edible insects from the wild was also stressed. “Development of mass raising techniques is mostly significant in the case of *Anaphe venata*, as noted by Ashiru (1988), since its host tree can be lost, *Triplochiton scleroxylon*, to logging. The saturniid caterpillar, *Cirina forda*, is the most commonly sold edible insect in Nigeria and sells for roughly double the price of beef. Others that are commonly marketed are palm grubs (*Rhynchophorus phoenicis*), termites, *Anaphe* larvae, and dried dragonflies”. Researches by Ashiru reveal “*Anaphe* grubs among the edible insects that are an abnormally good source of fat, containing high calories value of 6.113 kcal/g. Unfortunately, these grubs have in recent times come under a shadow for conceivable participation as the source of a seasonal ataxic syndrome. All age groups consume edible insects, for example *Oryctes* beetle larvae and termites are harvested mainly by women and children”.

Ene (1963) noted that "many educated and urbanized West Africans are either ignorant of, or reluctant to admit, the existence of certain indigenous customs such as the eating of insects;

customs which might be regarded as derogatory and are in any case fast disappearing away with the rapid improvement in education and living standards." However, an opinion poll survey conducted by Dr. Ene revealed that "a high proportion of West Africans have some information or knowledge with entomophagy. The bulk of responses to the feedback form were from Nigerian, Ghanaian and Cameroonian undergraduate students of Agriculture, Medicine and Zoology, and a few Nigerian university lecturers and their spouses". According to Ene, "Most people interviewed personally claimed their experiences were confined to a few occasions before adulthood when the insects were eaten out of curiosity or were offered by relatives or companions." Ene, in her own opinion, said that "educated people as considered edible insects to be too unclean or nauseating to be considered "as human food because of the many findings associated with disease infections. He notes: In fact, insects could offer man with decent quality food either directly or indirectly... Queen and alate termites, for example, stay in underground brood compartments which are kept 'spic and span' by the worker-termites and are nursed all through with 'processed' food. Therefore, they must be sensibly clean and pure. Moreover, it possibly would be much easier to produce processed proteins from insect soft tissue than from grass or sawdust or any of the other plant materials as is being tried by researchers in various nations. Properly processed and sold, edible insects therefore, could augment the world's insufficient supply of proteins and fats".

Ene states that "the insects used as food are those which are mostly harvested in abundance. Just after rainfall, flying termites are trapped in basins of water around which lights are placed, or in pits dug in front of the holes through which they are emerging. After cleaning and salting, they are usually roasted or tied in parcels and boiled." "Crickets are excavated individually or flushed out of their holes with water at nighttime". "Edible beetles are picked up around fruit trees and where palm wine is being tapped. Their larvae are found in the fluff around the leaf bases of palm trees, and inside decaying tree trunks in the forests."

Anthony and Isoun (1982) state in the Nigerian Cookbook that: "Different kinds of edible insects and grubs are seasonally predominant in some areas. Their own oil can be used to fry them and salted for appetizers either alone or with a cooked energy food.

2.14 Overview of Commercialization

Agricultural commercialization as a concept has been defined differently in various studies. For instance, Govereh *et al.*, (1999) and Pradhan, Dewina and Minsten (2010) defined “agricultural commercialization as the practise of increasing the quantity of agricultural production that is traded by farmers”. However, in Okezie, Sulaian and Nwosu (2012), an income concept of agricultural commercialization was used. “In this case, agriculture subsistence orientation is measured by the extent to which the farm households consume out of their aggregate agriculture produce as compared with the value of total production”.

According to Pingali and Rosegrant (1995) “agricultural commercialization can extend beyond the selling of farm output to include both the product choice and input use choices that are based on the ideologies of profit maximisation”. Their argument was “that as farmers commercialise, household’s mixed agricultural systems pave way to specialised production units that are intended to speedily respond to market and use quality inputs”. As the opportunity cost of household labour increases, households tend to move from using non-traded to tradable inputs such that households start to employ more labour as the demand for agricultural commodities increased. One debatable issue arising from their definition is the assumption of profit maximisation which theoretically is unattainable in a context of pervasive market failure such as in Nigeria.

An extensive explanation of agricultural commercialization was provided by Jayne, Haggblade, Minot and Rashid (2011). The study referred to “small holder commercialization as the virtuous

cycle in which farmers intensify their use of productivity enhancing technologies on their farms, achieve greater output per unit of land and labour expended, produce greater surpluses (or transition from deficit to surplus producers), expand their participation in markets and ultimately raise their incomes and living standards”. “Agricultural commercialization takes many forms and is defined in diverse ways. Smallholder commercialization in agriculture can be defined in terms of smallholder participation in commercial input and output markets, type of crops grown by smallholder farmers and goals (objectives) of smallholder farmers” (FAC, 2012). According to Gebre-Ab (2006) “agricultural commercialization can occur either on the input side with increased use of purchased inputs or occur on the output side of production with increased marketed surplus (sale of a marketable surplus of traditional crops)”.

Discussions around agricultural commercialization has separated farmers into various “types of farm: small farms and large farms, planting different types of crops i.e food crops and cash crops with simple differences made between ‘subsistence’ and ‘commercial’ or ‘export’ agriculture” (Leavy & Poulton, 2007; Chirwa and Matita, 2012). This discussion has led to the view that commercialization is only associated with large scale farming and overlooking “the fact that the small producer and poor farm families take part in the market either because they produce a little excess or trade to earn money to meet other family needs” (Rahut, Castellanos and Sahoo, 2010). In effect, “commercialization is about increasing engagement with markets, increasing inputs and factors of production acquired from the market, using markets to hire labour, and borrowing funds to rent land, obtain technical advice and market information” (Wiggins, Argwings-Kodhek, Leavy and Poulton, 2011). However, according to Gebre-Ab (2006) “the production of marketable surplus of staple food over what is needed for self -consumption is initially the most common form of commercialization”.

“Commercialization of agriculture includes a shift from subsistence agriculture to progressively commercial-oriented forms of production and input usage”. “Commercialization can achieve agricultural transformation by shifting production practices from current consumption-orientation towards market-orientation” (Brush and Turner, 1987; Pingali and Rosegrant, 1995; World Bank, 2008). “Smallholder commercialization is described as a pillar of household livelihoods” (von Braun and Kennedy, 1994); “a cornerstone of rural development and poverty reduction” (Pender *et al.*, 2007)” and an indispensable pathway to economic growth” (von Braun & Kennedy, 1994). This means “that commercialization’s fundamental purpose is poverty mitigation and economic development via income growth”. According to Kirsten, Mpilla, Okello and De (2013) “the subsistence-oriented smallholders have the greatest need to commercialise to satisfy growing demand and partake in the resultant income-mediated benefits”.

Although there is no single, generally acceptable definition of agricultural commercialization, all the definitions confirm the general proposition of farm households’ engagement with markets (Wiggins *et al.*, 2011). Commercialization is not the same as specialisation. On the contrary, commercialization and diversification may well be related. Majority of the small producers want to produce a big quantity of staples for family consumption, due to fears about accessibility and price of food in markets. Also, they are often unwilling to take the risk of depending on one or two crops for their income. The specialisation versus diversification debate in agricultural commercialization made Pingali (2010) to argue “that for many farmers, the transition from subsistence to commercial staple crop production is far more pertinent than a complete shift to specialised high-value commodities”.

2.15 Determinants of Commercialization

Gaps still exist in the literature as regards comprehensive conceptualisation of the commercialisation level at a family level as well as to model and estimate commercialisation determinants and its impacts. The result of diverse cultural, social, economic, institutional and human factors affecting commercialisation at the household level permits a very good attention (Jaleta, Gebremedhin & Hoekstra, 2009).

Martey, Al-Hassan and Kuwornu (2012) studied cassava and maize crops commercialization in Ghana. The tobit regression results showed that extension services access, distance of farm to the nearest market, output price, market information and the size of the farm were the significant determining factor of commercialization. Similarly, Martey (2014) examined the “effect of the type of access to information on the extent of maize commercialization in Effutu Municipality of Ghana”. The truncated regression revealed that market information, farm size of the farm, education, gender, access to land, number of male adults in the household and non-farm income explained agricultural commercialization. Specifically, farm size and years of education (squared) had the highest (0.1875) and the lowest (-0.0027) marginal effects respectively. Hlongwane, Ledwaba and Belete (2014), while investigating market participation of maize farmers in South Africa, discovered that gender, marital status, infrastructure (proxied by area of land under cultivation), market information and access to credit were positively related to market participation while distance of farm to the market and external source of income (grants) exhibited negative relationship with maize farmers’ market participation. The logistic regression showed that external source of income (-1.665) had the highest coefficient while area of land (0.556) had the least coefficient. Zamasiya, Mango, Nyikahadzoi (2014) considered soya bean market involvement by smallholder farmers in Zimbabwe and found out that only 28.8percent of the surveyed households participated in soya bean market. Household asset ownership (radio), resource endowment (livestock), farm size, gender, distance of farm to the

nearest market and access to extension agents were discovered to be the factors affecting commercialization.

In Nigeria, Agwu, Anyanwu and Mendie (2012) reported that commercialization of farmers at household level in Abia State was considerably low: the result showed that studied done on some of the crops not a single one got a ratio that's above 30 percent. "Cassava came first having a ratio of 29.58 percent then maize with a ratio of 24.02 percent. Sweet potatoes emerged third having a ratio of 19.06 percent, cocoyam had 13.79 percent while and water yam was fifth with 13.55 percent". The regression results "showed that family size, farming experience, income, farm size, access to credit, distance to the market and membership of farmers' association were significant in explaining commercialization in the study area". Distance to the market has the highest coefficient (-8.656) which was significant at 1percent. Adejobi and Akinola (2013) reported that 74.3 percent of households commercialised their farm produce, although at diverse levels in Osun state. Muhammad-Lawal, Amolegbe, Oloyede and Lawal (2014) "assessed the commercialization of food crops among farming households in Osun state" with the result revealing that food farmers carried out complete commercialization with commercialization index of household at 51.7 percent and about 54.6 percent of the respondents were into complete commercialization.

Gani and Adeoti (2011) analysed market involment and poverty among Taraba farmers in Taraba state and found out that variables like family size, distance, education, cooperative membership and infrastructure were the important variables affecting farmers' market participation. Results of the logit model indicated that extension visit was the variable with the highest coefficient value (1.2285) and is significant at 5percent. Size of output came last in value with 0.0109 though at high level of significance (1percent). Egbetokun and Omonona

(2012) looked at the “determinants of farmers’ participation in food market in Ogun state” using probit analysis. The factors influencing farmers’ participation were age, marital status, labour source, experience in farming and land size. Marital status has the highest coefficient (0.177) while age has the least (-0.012). Okezie *et al.*, (2012) examined the farm-level determinants of agricultural commercialization in Abia state to observe the driving forces of commercialization. The results revealed that there was a substantial degree of market orientation, off-farm income source was important for commercialization and the variables of importance were labour (which has the highest coefficient value), fertiliser use and planting material.

Adenegan, Adepoju and Nwauwa (2012) investigated maize farmers’ market participation in Osun state with the aid of the tobit model. Output of the farmers, years of education, non-farm income access, and membership of farmers’ association, ownership of cultivating equipment and information means had significant and positive relationship with volume of sales which was used as proxy for commercialization. On the other hand, transportation cost and marital status negatively affect the dependent variable. The value of the coefficient of ownership of farm equipment (0.1944) topped the list while that of transportation cost (-0.0002) was at the bottom when arranged in the order of magnitude. Adenegan, Adams and Nwauwa (2013) considered the gender impacts on agricultural commercialization in Oyo state and came up with the following findings: size of the farm, income, land tenure system, food security and educational level in relation to gender factor had significant effect on agricultural commercialization with food security and labour cost negatively affecting agricultural commercialization. Land ownership (0.206) and farm size (0.739) were found to have the least and the highest values of coefficients respectively. Ohen, Etuk and Onoja (2013) “analysed market participation by rice farmers in southern Nigeria” and discovered that quantity of output (with the least coefficient), use of improved seed (with the highest coefficient), total land size,

contractual agreement and group membership had significantly influence the ability of the rice farmers to take part in output market. Maize farmers' market participation was studied by Adeoti, Oluwatayo and Soliu (2014) in Oyo state. Membership of producer group, farm size, output, education level road condition and transaction costs were the significant determinants of participation in the market. Among the significant variables, membership of producer group had the highest coefficient.

According to Agwu (2012), Gebremedhin and Jaleta (2010a) and Enete and Igbokwe (2009), "large household sizes detracts households from market orientation due to its effect on increasing household domestic consumption needs". Agwu and Ibeabuchi (2011) opined that "household income, both farm and non-farm, has the potentials of reducing dependency on the agricultural output and thus encourages commercialization". "Increasing income of the farm households will definitely result into an increase the likelihood of commercialization among the farmers". Martey *et al.*, (2012) had opined "that farm size influences the level of agricultural commercialization". "This implies increasing farm size, the likelihood of commercialization also increases". Agwu *et al.*, (2012), Omiti, Otieno, Nyanamba and McCullough (2009), Rios, Masters and Shively (2008) and Barrett (2007) reported that "the greater the distance to the market, the less likely the farmer's orientation towards commercialization". Oluwande and Mathenge (2010) reported that "farmer's membership of associations increase commercialization. Being a member of associations and groups has the possibilities of increasing access to information which is essential to production and marketing choices". One of the major factors affecting agricultural productivity among farmers, most especially the smallholder farmers is lack of credit. According to Lerman 2004; Martey *et al.*, (2012) "credits are expected to enhance farmers' skills and knowledge, link farmers with modern technology through the purchase of inputs (planting materials, fertiliser and crop protection), pay wages,

invest in machinery, or to smooth consumption as well as markets, ease liquidity and input supply constraints, and thus, leading to increased agricultural productivity, induced market orientation and participation and thus greater commercialization”. Kamara (2004) “used the least squares regression to examine the determinants of farmers’ use of chemical fertiliser, pesticide and high yielding seeds in maize production in Kenya’s Machakos district. The result showed a positive and significant relationship between access to market and farmer use of high yielding seeds as well as credit access”.

2.16 Review of Analytical Approaches to Measurement of Commercialization

There are several approaches to measuring agricultural commercialization depending on the dimension or the state being considered: static or dynamic (Jaleta *et al.*, 2009). At the fixed level, there are three indices: “output and input side commercialization; commercialization of the rural economy and degree of integration into cash economies” (von Braun *et al.*, 1994 in Jaleta *et al.*, 2009). “The first index measures proportion of agricultural output sold to the market and input acquired from market to the total value of agricultural production. In the second type, commercialization of the rural economy is defined as the ratio of the value of goods and services acquired through market transactions to total household income. Here, there is an assumption that some transactions may take place in-kind such as payments with food commodities for land use. Thirdly, the degree of household integration to the cash economy is measured as the ratio of the value of goods and services acquired by cash transaction to the total household income” (von Braun *et al.* 1994).

For example, “in assessing household-specific level of commercialization, Govereh *et al.* (1999) and Strasberg, Jayne, Yamano, Nyoro, Karanja and Strauss (1999) used a Household commercialization index (HCI), which is a ratio of the gross value of all crop sales per

household per year to the gross value of all crop production”. According to Jaleta *et al.*, (2009), “these diverse pointers usually originate from the way commercialization is conceptualised. A number of authors apply econometric models gotten from the conventional non-separable agricultural household models to assess their resource allocation choices for producing commodities eaten at home (food crops) versus those delivered to markets (cash crops). Others apply simple indices (ratios) to look at the magnitudes of resources or revenue gotten from the market. In certain cases, these indicators are concentrating on either input or output side commercialization, while in others, they combine the two indices and look at the whole market dealings of a farm household”.

Another set of indices are those introduced by Gabre-Madhin, Dawit and Dejene, (2007). These are: “sales-to-output ratio, total sales-to-income ratio, the net-market position and specialisation index/income diversification”. According to Gabre-Madhin *et al.*, (2007), “the sales-to-output ratio measures the gross value of all agricultural sales by a household as a percentage of the total gross value of its agricultural production”. “This ratio is related to what has been developed previously by diverse authors (Abercrombie, 1961; Cleave, 1974; Ruthenburg, 1980 as cited in Randolph, 1992; von Braun *et al.*, 1994) as the proportion of agricultural output marketed to overall agricultural production. The overall sales-to-income ratio is the fraction of the gross value of overall sales to overall revenue from crop production. In this index, revenue from crop production is presumed as a proxy to overall household revenue, overlooking revenue from livestock, off- farm and non-farm sources. The household position in the market is assessed using the proportion of volume of sales and volume of purchases to the overall volume of stock: the summation of storage from the earlier production year and production in the recent year. The specialisation index attempts to capture to what degree farm households are specialised in their production to capture the profits from comparative advantages: producing what they can

powerfully produce and purchasing what they cannot. This index measures the ratio of the value of procured agricultural products not made by farm households to the gross value of agricultural production”.

As indicated earlier, “one of the methods used in “evaluating household commercialization is econometric analysis”. For instance, von Braun *et al.*, (1994) stated that “allocation decisions could be estimated econometrically by using reduced form equations with an extended list of exogenous explanatory variables that affect many structural relations. However, data limitations and the difficulty of identifying the underlying structural coefficients from reduced form estimates and drawing conclusions about the specific impact of crucial variables makes it less attractive”.

On the other hand, available evidence in the literature revealed that “the most common approach used in measuring the degree of commercialization at a household level is the use of the proportion of sales from the total value of agricultural production” (von Braun, 1994) “which is actually the revealed marketing decision of a household, particularly for commodities that are potentially used for sale and home consumption” (Randolph, 1992). Therefore, this study made use of the ratio because of its computational ease and the fact that it shows household marketing decision.

$$HCI = \frac{\text{Gross Value of all edible insects sales}}{\text{Gross value of all edible insects harvested}} * 100$$

Zero value for HCI means total subsistence, while a higher value of HCI (value approaching 100) signifies higher level of commercialization.

2.17 Smallholder farmer commercialization: A review of analytical models

“Ordinary least squares (OLS), logit, probit or tobit regression techniques are usually employed for studies assessing the determinants of improved inputs use in production. The technique of

estimation for the analysis basically depends on the kind of data i.e categorical or continuous for the dependent variable. OLS regression is used when the data for the dependent variable is continuous, but for categorical data logit, probit or tobit regression are widely used” (Gujarati, 2003). Kamara (2004), “used the least squares regression to analyse the determinants of farmers’ use of chemical fertiliser, pesticide and high yielding seeds in maize production in Kenya’s Machakos district”. Kamara (2004) found that there was a “positive and significant relationship between farmers’ use of high yielding seeds and access to the market as well as credit access”.

The logistic model, which measures “the probability and degree of market participation, was applied in the study of smallholder farmers in the major coffee growing areas of Ethiopia” by Gebreselassie and Ludi (2008). Evaluation and interpretation is computationally easy. The tobit model was used by Martey *et al.*, (2012) in the quantification of the extent and direction of factors affecting intensity of commercialization of maize and cassava in Ghana. It was also applied by Strasberg *et al.*, (1999) while examining the effects of commercialization on food crop fertiliser usage and productivity. Geoffrey *et al.*, (2013), used the restrictive form to analyse output market supply while Bellemare and Barrett (2006), used ordered form in the study of market participation in Kenyan and Ethiopian livestock markets. Sebatta, Mugisha, Katungi and Kasharu (2012), used ordered probit. These models have advantages and disadvantages and their use depend on the context and focus of the study.

Other model commonly used is the Linear Probability Model. Nevertheless, it is imperative “to report robust (Eicker-White) standard errors because of the intrinsic heteroskedasticity of the linear probability model”. “The linear probability model has in practice several advantages over probit or logit estimation: it is easier to calculate, the parameters are directly interpretable, fixed effects and instrumental variables estimators can easily be implemented and

that adding fixed effects as dummy variables in the probit or logit model will yield biased estimates” (Wooldridge, 2008).

Tobit model is very useful when dealing with studies involving censored data. On the issue of estimation, when dealing with the issue of censored data, the method of maximum probability or related methods is usually applied. Though, “the validity of such procedures needs to precisely specify the error distribution which could be challenging in nature” (Chay and Powell, 2001).

Earlier studies on commercialization or participation in market have usually adopted the unobservable choice to “participate and the observed intensity of participation in the market (Omoti et al., 2009). For example, Katungi, Horna, Gebeyehu and Sperling (2011) analysed the determinants of the common bean yields and input use in their investigation of the effect of market conditions and commercialization on common bean intensification and productivity in Ethiopia with the aid of a two-step estimation procedure. In this case, models that control for selectivity or sample selection were used including “Heckman’s sample selection model or its variants of double hurdle and switching regression models”.

Heckman procedure was used by Bahta and Bauer (2012) in “their study on policy decisions for improving participation in market and sales of smallholder crop producers in the Free State Province of South Africa. The Heckman method assumes there are some possible production levels in the population that is sampled but are not noticed due to sample selection problem. In addition to this problem, the Heckman procedure yields steady estimations of the parameters which are not as effective as the maximum likelihood estimates (Gujarati, 2003). Heckman model is designed to account for the fact that observed sample may not be random”.

The sample selection model is considered appropriate over tobit because while tobit model “assumes that zero values associated with non-participation are outcome of rational choice (i.e.

corner solutions), the sample selection model explains non-participation using prohibitive transactions cost and other factors”. In addition, “the partial effects of a particular variable on the probability that the farmers will sell and on the expected value of the quantity traded i.e conditional participation have the same signs” (Wooldridge, 2002).

Asfaw, Shiferaw, Simtowe and Gebretsadik (2011) used double-hurdle method to test the effect of technology adoption on farmers’ integration to market in Ethiopia. Double hurdle was introduced as a more flexible alternative to tobit models (Burke, 2009a; Cragg, 1971). Asfaw *et al.*, (2011) “used the model in their study on agricultural technology adoption, seed access constraints and commercialization in Ethiopia”. Gobena (2012) also employed double hurdle model while examining “smallholder farmer’s participation in the production and marketing of sesame in a district in Ethiopia since the zeros in the level of sesame production (the dependent variable in the second stage) is due to non-participation in sesame production and not due to corner solution” (which can be taken care of by tobit) or sample selection problem (that can be taken care of by Heckman). The double-hurdle model “allows for the distinction between the determinants of production participation and the level of participation in production through two separate stages thus enabling estimation of production decisions (in first stage) with probit regression and the level of production participation (in second stage) with truncated regression” (Burke, 2009b).

“Triple-hurdle model, which is an adaptation of double-hurdle, was used by Burke (2009b) in his work on smallholder production and marketing participation in Kenya’s dairy sector. The study sought to examine the factors enabling participation of smallholder in Kenya’s dairy market and to use the discoveries to identify strategies to increase dairy productivity and promote successful smallholder commercialization”. According to Burke (2009b), “the traditional double-hurdle market participation models are not adequate for addressing these

objectives, mainly because they (double-hurdle models) require the implicit assumption that all farmers are producers, whereas roughly one-third of rural Kenyan households do not produce milk in a given year”. Triple model was thus brought up to allow both non-producers and autarkic producers.

Another set of models are the quasi-experimental design approaches. Estimation of causal impact from observation data is not trivial because of the difficulties in finding a counterfactual (Asfaw *et al.*, 2011). “Experimental research designs provide the most credibly unbiased estimates, but experiments are often infeasible due to price or moral complaints”. “Four types of quasi-experimental research designs offering approaches to causal inference using observational data are discussed below in rough order of increasing internal validity (Shadish, Cook, Campbell, 2002): Ordinary regression and panel methods, matching and reweighting estimators, instrumental variables (IV) and related methods and regression discontinuity (RD) designs”.

The selection bias also known as “omitted-variable bias in an ordinary regression occurs from endogeneity (a regressor is said to be endogenous if it is correlated with the error), a situation that also arises if the explanatory variable is measured with error or in a system of simultaneous equations for instance., suppose that work also has a causal effect on emotional health or higher income cause increases in education; in this case, it is not clear what impact, if any, our single-equation regressions identify)”. “To eliminate bias, the regression and panel methods normally involve confounding variables either to be measured directly or to be invariant along at least one dimension in the data, e.g., invariant over time. The matching and reweighting estimators require that selection of treatment depend only on observable variables, both a stronger and weaker condition. Instrumental variable methods require extra variables that affect the predictor but not outcomes directly and throw away some information in predictor to get less efficient

and biased estimates that are, however, consistent (i.e. approximately unbiased in sufficiently large samples). Regression discontinuity methods require that treatment exhibit a discontinuous jump at a particular value (the “cut-off”) of an observed assignment variable and provide estimates of the effect of predictor for individuals with exactly that value of the assignment variable”. In practice, “the data often dictate the method, but it is incumbent upon the researcher to discuss and check (insofar as possible) the assumptions that allow causal inference with these models” (Nichols, 2007).

In economic analysis, cases of endogeneity, situations where at least one of the explanatory variables is determined together with the dependent variable, are usually encountered. Instrumental variables approaches are used to take care of such situations. Generally, instrumental variables are applied to correct omitted variables bias, simultaneity/reverse causality and measurement error which are encountered in the conventional OLS regression. When endogeneity problem arises (an example of which is the correlation of one or more regressors with the error term), the OLS cannot give a consistent estimate of the causal effect of regressor on the dependent variable. In such situations, “exogenous variables which are correlated with the endogenous regressor but not with the error term are utilised. These are the instrumental variables. If there are enough of such variables, the correct estimate of the causal effect of the regressor on the dependent variable can be obtained” (Schmidheiny, 2014).

Gebremedhin and Jaleta (2010b) used instrumental variable approach in the study of market participation and orientation as it affects commercialization in Ethiopia. Land fragmentation and altitude were used as instruments to test for endogeneity since both were not expected to affect participation in the market after controlling for market diversification and market orientation. Apart from tobit regression which was used specifically for fertiliser model because almost half of the sampled households do not apply fertiliser to food crops: a case of censoring,

Strasberg et al., (1999) made use of the instrumental variable (IV) approach for the productivity model due to the fact that fertiliser and hybrid maize seed which are the main input variables were found to be endogenous to the determinants of productivity.

Govere et al., (1999) examined the effects of household-level crop commercialization on farm capitalisation or fertiliser use on crops with instrumental variable. Govere and Jayne (2003), in the study of the interactions “between cash cropping and food crop productivity at the household level” in Zimbabwe, also employed the instrumental variable because cotton commercialization and food crop production were endogenously determined. The relevance of the method was premised upon finding instruments that correlated with the commercialization index used (Cotton Commercialization Index – CCI) but not production of food or yields. The instrumental variables used included the distance from every household to the cotton-buying outlet and the quantity of cotton sprayers possessed by the household. In the same vein, Rios, Shively and Masters (2009) applied IV in a 2SLS approach to deal with the endogeneity of market participation in Tanzania, Vietnam and Guatemala.

2.18 *The Household Livelihood Security (HLS) Framework*

The livelihood method emerged from “the food crisis in the mid 1980s and Sen’s (1981) theory on entitlement pointing to the set of income and resource bundles (e.g. assets, commodities) over which families can establish control and guard livelihoods. The evolution of the concepts and matters related to this theory finally led to the development of the extensive concept of Household Livelihood Security” (HLS).

“The diversity in the explanation of livelihood approaches by various development agencies” was documented by Hussein (2002). One of them is CARE. CARE considers “this approach as

its important part of program intervention and HLS was defined as adequate and sustainable access to income and resources to meet all the basic needs and rights” (Carney, 1999). “This concept of HLS symbolizes three essential qualities of livelihoods: (1) the possession of human capabilities (e.g., education, skills, health, psychological orientation); (2) access to tangible and intangible assets; and (3) the existence of economic activities. The interaction between these qualities defines which livelihood strategies a household will follow to reach its anticipated outcomes, known as CARE’s HLS model”. Simply speaking, “livelihood security here refers to the ability of the household to meet its basic needs (or realize its basic rights)”. “These needs include adequate food, health, shelter, minimal levels of income, basic education, and community participation” (Frankenberger, Drinkwater and Maxwell, 2000).

2.19 Construction of the livelihood security indices

CARE “developed a set of many indicators to measure each of the eight livelihood security results of the HLS framework based on a thoughtful workshop involving several other NGOs in Bangladesh” (for details, see CARE, 2004). A group of “indicators from these recommended set were selected from the study (CARE, 2004) which can be derived from the survey data to build the livelihood security indices”. “It is worth mentioning that CARE has developed a compositeHLS index using rapid community appraisal techniques and selected sample household interviews by using a team of 10-12 persons spending about eight hours in a community” (Lindenberg, 2002).

In this study, “a composite set of HLS indices at the household level was developed by applying a set of indicators indicating each of the livelihood security areas using an approach similar to Hahn, et al. (2009)”. These indices are; “economic security, food security, health security, educational security and empowerment” (Lindenberg, 2002). “Indicators are recognized

according to its significance and it is expected that each indicator carries the same weight and adds to the total HLS index”. Hence, the carefully chosen “indicators are standardized following the approach adopted in measuring Life Expectancy in Human Development Reports (also adopted by Hahn, Riederer and Foster, 2009; Shaheen and Sanzidur, 2012). For instance, a standardized indicator j of a household is given by:

$$zind_j = \frac{indicator_j - \min j}{\max j - \min j} \quad (1)$$

“where the minimum and maximum values of the indicators are from the same area where the household belongs. Once each indicator representing a particular livelihood security domain is standardized, then the relevant household livelihood security index for the particular domain is constructed by averaging the standardized indicators:

$$HLS_i = \frac{\sum_{j=1}^n zind_j}{n} \quad (2)$$

where j is the number of indicators used to construct the index. Once each HLS index is constructed, then the composite overall Livelihood Security (LS) index for the household is constructed by using the formula in equation (3):

$$LS = \frac{\sum_{i=1}^n w_i HLS_i}{\sum_{i=1}^n w_i} \quad (3)$$

where w are the weights determined by the number of indicators used to construct each HLS index. Weights vary between households because of the disparity in the number of indicators at the household level”.

Conceptual Framework for Edible Insects Commercialization

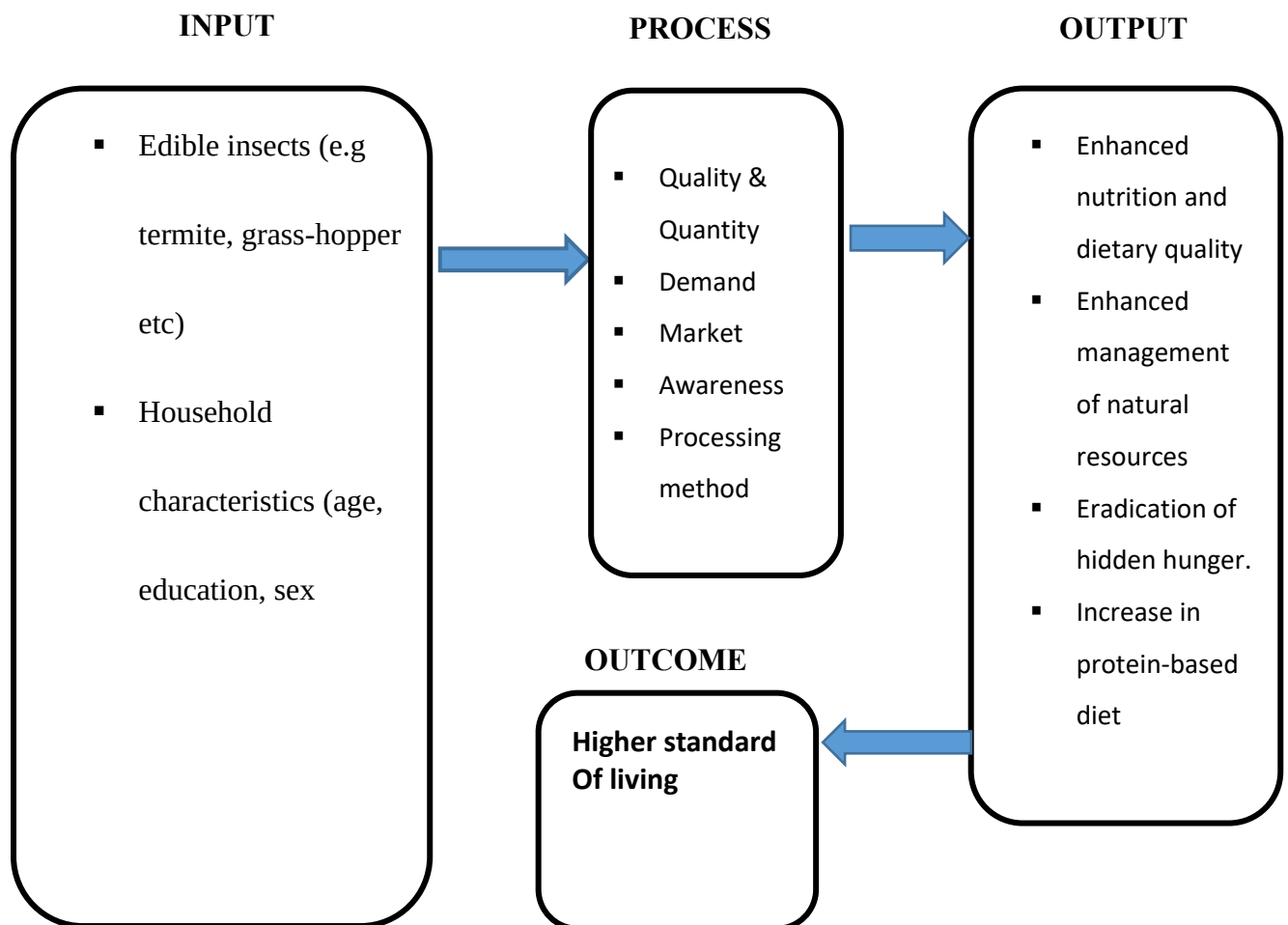


Figure 2: Conceptual Framework

Source: Author's design

The conceptual framework that underlies this work is presented on figure 2. Given the forest resource (edible insects) and the household factors, commercialization of edible insects is expected to generate extra income for the rural households following the processes involved in making it's consumption appealing to the teaming population. Its consumption and commercialization will

bring about enriched and quality nutrition, improved management of natural resources, eradicate hidden hunger and increase protein- based diet. And as a supplementary income, it will help rural households to have higher standard of living.

2.20 Analytical Framework

2.20.1 Marketing Margin

Marketing margin means the finished goods that are purchased and re-sold. It is also the difference between the buying price of a product and the price at which you sell the product through channel of distribution. Marketing margin is calculated by “deducting the price per unit from the selling or retail price. For example, if the selling price of a product is ₦5 and the cost per unit is ₦3. In this case the marketing margin is ₦2 per unit. This means that for every edible insect you process and sell, you are earning ₦2 for every product unit that you process and sell”.

2.20.2 Tobit Regression.

The Tobit model is also popularly known as a “*censored regression model*”. “It is designed to evaluate linear relationships between variables when there is either *left- or right-censoring* in the dependent variable which is also known as censoring from below and above, respectively. Censoring from above occurs when cases with a value at or above some threshold, all take on the value of that threshold, so that the true value might be equal to the threshold, but it might also be higher. In the case of censoring from below, values that fall at or below some threshold are censored”.

The structural equation in the Tobit model is:

$$y^*i = Xi\beta + \varepsilon i$$

2.20.3. ORDINARY LEAST SQUARE REGRESSION

“*Ordinary least squares (OLS) regression* is a statistical method of analysis that estimates the relationship between one or more independent variables and a dependent variable; the method estimates the relationship by minimizing the sum of the squares in the difference between the observed and predicted values of the dependent variable configured as a straight line. In this entry, OLS regression used in this study first applied a bivariate model, that is, a model in which there is only one independent variable (X) predicting a dependent variable (Y). However, the logic of OLS regression is easily extended to the multivariate model in which there are two or more independent variables”.

The implicit form of this model is written as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, \dots, U)$$

2.21. Empirical Evidences on Under-utilised species and Food security

Adeoye, Alebiosu, Akinyemi and Adeniran (2014) examined the “Socio-Economic Analysis of Forest Edible Insects Species Consumed and Its Role in the Livelihood of People in Lagos State”. The study showed that edible insects are used as a meat substitute and sold in riverine areas of Lagos State and *Rhynchophorus phoenicis* was the most marketed. Available “information on the marketability of edible insects and its nutritive value in Lagos State disclosed their economic value, harvesting and processing styles by consumers as well as marketers”.

Isaac and Ayodeji (2014) “examined the contributions of *Thaumatococcus daniellii* to livelihood security in rural Southwest Nigeria” using logistic regression. The study revealed “that the majority of income realized by the respondents were made from this specific NUS either from its production, processing or marketing. The result of the logistic regression revealed

poverty status, educational status and participation in off-farm activities were important correlates of harnessing the crop”.

Osewa, Alamu, Adetiloye, Olubiyi and Abidogun (2013) carried out an investigation on the “use of some Neglected Underutilized Plant Species” in Oyo State Nigeria using both the chi-square analysis and multiple regression analysis. The result of the chi-square indicated a “significant relationship between rural dwellers’ educational level and the use of neglected and underutilized plant species at 0.05 level of significance while age, sex, and marital status were not significantly related to the use of NUPS by rural dwellers. The multiple regression analysis showed that there is a strong correlation between the benefit knowledge, information exposure and the use of NUPS”.

Alamu, Amao, Nwokedi, Oke and Lawal (2012) reviewed the literature on the “diversity and nutritional status of edible insects in Nigeria”. The study showed that “edible insects are high in protein and amino acid, particularly essential amino acid for the human body”.

Olagunju, Oke, Babatunde and Ajiboye (2012) “assessed the determinants of food insecurity in Ogbomoso metropolis, Oyo state using a binary logit model”. The study revealed that “age of household head, the amount of credit received, family size, annual income, farm size and livestock owned” were statistically significant.

Benjamin, Asogwa and Joseph (2012) “investigated food insecurity determinants among rural households in Nigeria using Tobit regression model”. The study revealed that “larger family size had a higher probability to be food insecure”.

Magbagbeola, Adetosio and Owolabi (2010) carried out a study on “NUS; a panacea for community-focused development to poverty alleviation/ reduction in Nigeria” using descriptive and empirical analysis. It was observed that the more educated the people the higher their per capital income.

Agbidye, Ofuya, and Akindele (2009) investigated “the marketability and nutritional qualities of the edible forest insects in Benue State”. The study has shown that “edible insects are marketed in Benue State with the most marketed being *C. forda* and *Bematistes alcinoe*, *Mastomys natalensis*, *Brachytrupes membranaceus*”. The study revealed that “edible insects are of high nutritive value having as high as 74% crude protein in the prepupae of *C. forda* and *B. alcinoe*”.

Agbidye et al (2009) “surveyed the Edible Insect Species Consumed by the People of Benue State”. The study showed that “people of Benue state consume edible insects with more than ten (10) species of insects from 5 Orders and 8 Families being eaten during the period under study”.

Omotesho and Muhammad- Lawal (2009) “analysed the food security and poverty of the rural households in Kwara State, Nigeria using food security index. The result revealed that only about 48.28% of rural dwellers are food secure. The mean daily energy and protein available to the food secure households are 13,655.24kcal and 340.34g respectively. 51.72% of the rural household are food insecure. The mean daily energy and protein available to food insecure households are 13593.62kcal and 334.41g respectively”.

Babatunde, Omotesho and Sholotan (2007) examined the “socio- economic characteristics and food security status of farming household in Kwara State using logit regression. The study revealed that using the recommended calorie approach, 36% and 64% of the household were food secure and food insecure respectively”.

Omotesho, Adewumi, Muhammad –Lawal, Ayinde (2006) examined the “determinants of food security among rural households in Kwara State” using logistic regression model. The findings revealed “that about one-third of the rural farming households sampled was food secure and

that size of farm, gross farm income, overall non-farm income and family size are the significant determinants of rural household food security in the study area”.

Arnold (2003) reviewed an article “on insects as food in Sub- Saharan Africa. A list of about 250 edible insect species from Africa was compiled”. The study revealed that “insects are high in protein, vitamins and minerals and a good source of Iron and B- vitamins and revealed also that insects are consumed not only on taste and nutritional value but also on customs, ethnic preferences or prohibitions”.

From the foregoing, the study therefore adopted Marketing margin, Household Commercialization Index, Tobit regression model and Ordinary linear regression model. HCI helped reveal farmers levels of commercialization. Marketing margin was used to measure the returns generated from the commercialisation of the edible insects. Tobit regression was used to find the determinants of commercialization. OLS was used to determine the contribution of commercialization to the livelihood status of the respondents.

2.22 Literature Gap

Although several studies have looked at Neglected and Underutilized species using various crops, vegetables and trees as their case studies but no study has considered Edible insects as NUS.

CHAPTER THREE

3.0 METHODOLOGY

This section presents the discussion of the study area, sampling techniques and the analytical tools employed to achieving the objectives of this study.

3.1 Study area

The study was carried out in Benue state, Nigeria. “Benue State is located between latitudes 7°30′N and 8°10′N and between longitudes 7°30′E and 9°50′E. The State lies in the transition belt between the tropical rain forest of southern Nigeria and the open grassland savanna vegetation of northern Nigeria” (Benue State Diary, 2007).

Benue State is “popularly referred to as Food Basket of the Nigerian nation and it’s one of the 36 States of Nigeria. Benue state has Makurdi as the capital city and was created on February 3, 1976”. The State has “23 Local Government Areas (LGAs) with a population of 4,219, 244” (Newspaper, daily trust 2007). “The State occupies a landmass of 30, 955 square kilometres. Tiv, Idoma, and Igede are the major ethnic groups in the State (Benue State Diary, 2007). Benue State is located between latitudes 6°30′N and 8°10′N and between longitudes 7°30′E and 9°50′E”. “The State lies in the transition belt between the tropical rain forest of southern Nigeria and the open grassland savanna vegetation of northern Nigeria” (Benue State Diary, 2007). “Common tree species in Benue State include: Silk cotton tree, *Ceiba petandra*; *Daniellia oliveri*; chocolate berry, *Vitex doniana*; *Afzelia africana*; Shea butter tree, *Vitellaria paradoxa*; Khaya, *Khaya senegalensis*; *Nauclea diderichi*;, *Terminalia schimperiana*; Ironwood, *Prosopis africana*;;detar, *Detarium microcarpum*; bush mango, *Irvingia gabonensis*; African pear (bush

butter), *Dacryodes edulis*; Locust bean tree, *Parkia biglobosa*” (Nwoboshi, 1982; Cole, 1986; Keay, 1989). “Benue State experiences a typical tropical climate with two distinct seasons, the rainy season and the dry season. The rainy season lasts from April to October. The annual rainfall total ranges from 1,200mm to 1,500mm. The dry season begins in November and ends in March while mean monthly temperatures fluctuate between 23°C and 30°C in the year”.

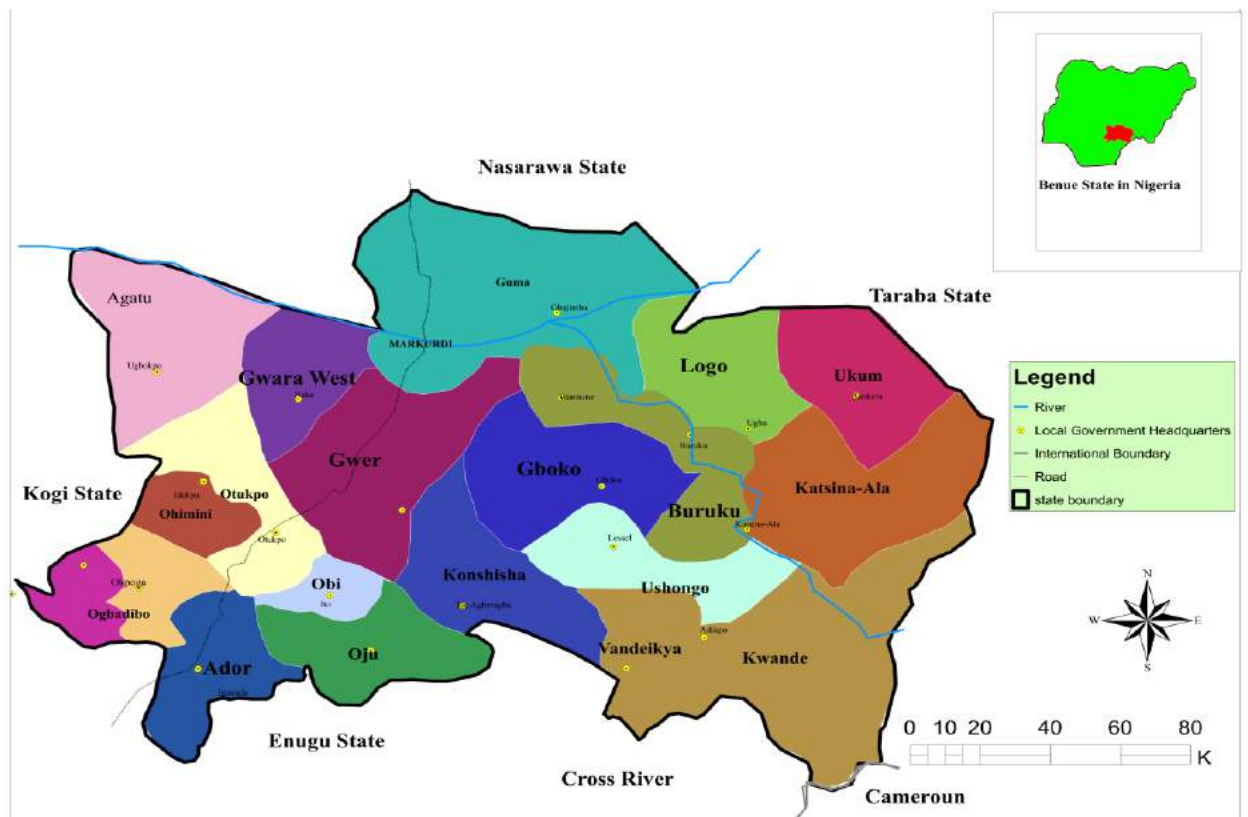


Figure 3: Map of Benue state, Nigeria.

3.2 Sampling Techniques and Sample Size

The respondents for this study were the rural households in Benue state. A 2-stage random sampling technique was used to select respondents. First stage of the sampling procedure involved the purposive selection of 5% out of the 368 rural communities in Benue State. The second stage involved a snowball sampling of rural households which was adopted to get at

least ten (10) households from each village (who then provided a link to other households and the cycle continued till the final respondent was reached) which gave a total of 156 respondents for the study.

3.3 Methods of Data Collection

The type of data used for this study was Primary data. This data was collected using a structured questionnaire and an oral interview of edible insects' processors to source for more information from the respondents. Data was collected on types of insect harvested and commercialized, sources of insects, methods of collection, methods of processing, and methods of preservation used in the last harvesting season (2018). This harvesting season is the period of the year when edible insects are said to be in abundant and this season start from March (at the onset of rainy season) to July every year.

3.4 Analytical Techniques and Model Specification

“Descriptive statistics was used to explain the various edible insects available in the study area using frequency distribution, mean, and percentages etc. Marketing efficiency was also used to analyse returns to edible insects' commercialization. Household Livelihood Security Index was constructed to estimate the livelihood status of households. Other tools like Household Commercialization Index, Tobit Regression Model and Ordinary Least Square Regression model were also used to analyse data for the study”.

3.4.1 Household Commercialization Index (HCI)

Household commercialization is defined as a proportion of total output sales. The HCI was used to assess the level of commercialization of edible insects in Benue state. “The Household Commercialization Index (HCI) was proposed by Govereh *et al.*, (1999) and Strasberg *et al.*,

(1999)”. The approach is to consider the percentage of crop production marketed by a farming household. Edible insects were used instead of crops in the formula below.

$$HCI = \frac{\text{Gross value of all processed edible insect sales}}{\text{Gross value of all edible insects collected}} * 100$$

Zero value “for the HCI signifies total subsistence while a higher value of HCI approaching 100 shows higher degrees of commercialization”. “The measure is intended to measure commercialization in a scale-neutral manner, independently of the household’s wealth” (Rios et al., 2008). This was used to analyse objective two.

3.4.2. To examine factors affecting level of commercialization of edible insects using Tobit regression model (Objective 3)

The implicit form of this model is written as:

$$y^* = x\beta + u, u|x \sim normal(0, \sigma^2)$$

Where:

Y_1 = Household Commercialization Index

X_1 = Marital status of the household head (married=1, others=0)

X_2 = Gender of the household head (female =0, male =1)

X_3 = Membership in association of the household head (Yes =1, No= 0)

X_4 = Primary occupation of the household head (Non farming =1, farming =0)

X_5 = Yearly income of household head (₦)

X_6 = Household size

X_7 = Distance of home to nearest village market (km)

X_8 = Years of schooling of household head

U = Error term

The Household Commercialization Index was computed for each household using the ratio of total quantity of raw insects processed (kg) and total quantity of edible insects harvested (kg) multiplied by 100%. Commercialization was further categorised into three levels (Low, Medium and High) using the work carried out by Shehu 2016 on agricultural commercialization, input use and non-farm employment (Unpublished).

3.4.3 Estimating the Livelihood Status of Household Using Household Livelihood Security Analysis

Economic Security Indicator

The indicators that were used to estimate the Economic security index of households included:

Household per capita farm income (Naira per year)

Household per capita non-farm income (Naira per years)

Household per capita Asset value (Naira)

Active population (15 – 59years) ratio =
$$\frac{\text{No. of Active household members}}{\text{Total household size}}$$

Food Security Indicator

Household dietary diversity score (No. of food groups per day)

Food frequency (No. of meals and snacks per day)

Household per capita monthly food expenditure (Naira per month)

Household per capita calorie intake (Kilocalorie per Adult Equivalent per day)

Health Security Indicator

Number of days unable to work due to sickness in the last 30days

Household per capita monthly health expenditure (Naira per month)

Frequency of visiting hospital in the last 30days

Education Security Indicator

Years of schooling of household head (years)

Number of household adult male (15+) with formal education

Number of household adult female (15+) with formal education

Number of 6 – 10years children enrolled in school

Number of >10years children enrolled in school

Empowerment Security Indicator

Membership of community societies (No. of societies belonging to)

Proportion of household members in society

How the indicators were calculated

The study used “quantitative approach to measure HLS status of the respondents” in the study area. Five indices were used to compute HLS index. These indices include; “economic, food, health, education and empowerment”. These indicators were “identified according to its significance and it is assumed that each indicator carries the same weight and adds to the overall HLS index. Hence, the chosen indicators were standardized following the procedure used in measuring Life Expectancy in Human Development Reports” (also adopted by Hahn, et al. 2009). The standardized indicators were then summed to give a composite indicator. Using the economic security indicator for example

Household per capital farm income = (Farm income / Adjusted household size)

Household per capital farm income index = (Indicator- minimum value)

(Maximum value- Minimum value)

Household per capital non- farm income = (Non- farm income / Adjusted household size)

Household per capital non- farm income index = (Indicator- minimum value)

(Maximum Value- Minimum value)

Household per capital asset value index = $\frac{(\text{Indicator- minimum value})}{(\text{Maximum Value- Minimum value})}$

Active population ratio = $\frac{\text{No. of Active household members}}{\text{Total household size}}$

Active population ratio index = $\frac{(\text{Indicator- minimum value})}{(\text{Maximum Value- Minimum value})}$

Then, the values gotten from these indices were added and divided by 5 to give Economic security Indicator. Same procedure was followed to obtain values for other indicators and the division was done based on the number of indices under each indicator.

For the composite indicator therefore, I then summed all the values of the indicators and divided by n; my n here was 5

$$\frac{\text{Economic security indicator} + \text{Food security indicator} + \dots \text{Empowerment security indicator}}{n}$$

Furthermore, the Household Livelihood Status (HLS) of the respondents was classified into two; Low HLS and High HLS using the Household Livelihood Security Index average which was 0.27.

3.4.4. Returns to edible insects commercialization (of the last harvesting season) using Marketing margin (Objective 4)

Marketing margin = Sales price – Cost price.

Labour was used as proxy to capture cost price of edible insects. The marketing margin for each of the edible insects was calculated using the above formular.

3.4.5 To determine the contribution of edible insects commercialization to the livelihood status of the rural households using Ordinary Least Square Regression Model (Objective 5)

The implicit form of this model is written as:

$$Y = f(Z) \dots\dots\dots (1)$$

Where

Y= Household Livelihood Security Index

Z= Household Commercialization Index

$$Y = f(Z_1, Z_2, Z_3, Z_4, Z_5 \dots\dots\dots U) \dots\dots\dots (2)$$

Where:

Y_1 = Household Livelihood Security Index

Z_1 = Household commercialization Index.

Z_2 = Gender (female =0, male =1)

Z_3 = Years of processing of edible insects

Z_4 = Primary occupation of household head (Non farming=1, farming =0)

Z_5 = Distance of home to nearest village market (km)

Z_6 = Number of extension contacts

Z_7 = Amount of credit received from financial institutions (₦)

U = Error term

Limitations to the study.

Since the study was a cross sectional survey there is possibility of inaccurate measurement of some data collected relating to quantities of edible insects harvested, processed and sold because the survey was not an experimental survey where the respondents were supposed to be followed right from the point of collection to processing and finally to commercialization. The study therefore relied mainly on rural households' memory recall which may be inaccurate. Estimating Household Livelihood Status of the respondents also posed a little challenge. They were reluctant to disclose their monthly income and their health status. This in a way might have affected the reliability and correctness of the collected data

Table 1: Table of Analysis

S/N	Objectives	Data required	Methods of Analysis
1	To enumerate various edible insects in the study area	Edible insects data	Descriptive analysis using frequency distribution and percentages
2	To determine the level of commercialization of edible insects among rural households	Edible insects data	Households' Commercialization Index (HCI)
3	To examine factors affecting the level of commercialization of these edible insects among rural households	Edible insects data	Tobit regression model
4	To analyse returns to edible insects commercialization.	Socio economic data, processing data	Marketing Margin

5	To determine the contribution of edible insects commercialization to the livelihood status of the rural households	Socio-economic data, livelihood data	Ordinary Least Square regression Model
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CHAPTER FOUR

4.0

RESULTS AND DISCUSSION

This chapter comprises the presentation of results and discussion of this study. This includes socioeconomic characteristics of the rural households, access to credit, source of credit and amount received from financial institution, major under-utilised edible insects commercialised in the study area, underutilized edible insects processing characteristics, level of household commercialization of under-utilised edible insects, factors affecting the level of commercialization of under-utilised edible insects, household livelihood security index of respondents, marketing efficiency of each of the underutilized edible insects and the contribution of commercialization of edible insects to the livelihood status of the respondents.

4.1. Socio-Economic Characteristics of the sampled rural households

Table 2 shows the socio-economic characteristics of rural households involved in the commercialization of underutilized edible insects. The variables for the socio economic characteristics include age of the household head, sex of the household head, marital status of the household head, the household size, education status of the household head, membership of association of the household head, extension contacts, primary occupation of the household head and processing experience of the household head.

Table 2: Distribution of Respondents by Socio-economic characteristics.

	Variables	Frequency n=156	Percentage
1	Age		
	< 30	24	15.39
	31 - 40	53	33.97
	41 - 50	42	26.92
	51 - 60	31	19.87
	> 60	6	3.85
	Mean	43.08	

	Minimum	19	
	Maximum	65	
2	Sex		
	Female	41	26.28
	Male	115	73.72
3.	Marital status		
	Unmarried	32	20.51
	Married	124	79.49
4.	Membership of association of the household head		
	Yes	71	45.51
	No	85	54.49
5.	Household size		
	≤5	87	55.77
	6 -10	65	4.67
	≥ 10	4	2.56
	Mean	5.5	
	Minimum	1	
	Maximum	15	
6.	Educational level		
	No formal education	1	0.64
	Qur'anic education	3	1.92
	Primary education	43	27.56
	Secondary education	50	32.52
	Tertiary education	45	28.85
	Adult education	14	8.97
7.	Farm size (ha)		
	1-2	82	52.60
	3-5	64	41.00
	>5	10	6.40
	Mean	2.9	
	Minimum	0	
	Maximum	30	
8.	Number of extension contact		
	No contact	103	66.03
	Once	25	16.03
	Twice	28	17.95
9.	Primary occupation		

	Farming	72	46.15
	Trading	28	17.95
	Artisan	24	15.39
	Civil servant	32	20.51
10.	Years of processing		
	≤10	80	51.28
	11-15	35	22.44
	16-20	29	18.59
	>20	12	7.69
	Mean	12.70	
	Minimum	2	
	Maximum	40	

Source: Field survey 2018/2019

Table 2 presents the socio-economic characteristics of respondents. Analysis of the data reveals that the respondents have a mean age of 43 years, a sign that most of the rural household are relatively still in their active working age. This is similar to the work carried out by Isaac and Ayodeji (2014) on socio-economic contribution of neglected and underutilized species to livelihood security in Rural Southwest Nigeria. The table shows that the majority of the respondents (73.72%) were male whereas the remaining (26.28%) were female. This implies that more males were into the commercialization of the underutilized edible insects than females. The low involvement of women suggests that harvesting of edible insects might be labour intensive. This is similar to the work carried out by Martey (2014).

Majority of the respondents (77%) were married. Marital status is used to determine stability because there's a general notion that the married are more stable than the unmarried in farming due to the family labour that will be supplied by the family members. 45% of the respondents belonged to a farmer's association while about 55% did not. The table 2 further shows that the mean household size of the respondents was 5. Respondents with a larger household size are likely to commercialize more due to their greater consumption needs.

Furthermore, majority of the respondents (33%) had at least secondary school education. This implies the respondents can read and write and can make informed decisions. From the table 2, about 46.15% of those surveyed had farming as their major occupation with less than 30% of them engaged by the government as civil servants.

The categories of households having farm size between 1-2ha constituted about 52.6% and about 47.4% had greater than 3ha. The mean farm size was 2.90 ha. Table 2 reveals that about 51.28% of the respondents had between 1-10years processing experience and about 7.69% of them had greater than 20 years processing experience.

4.1.2 Respondents Access to Credit.

Table 3 shows the distribution of respondents based on access to credit, source of credit and amount of credit received from financial institutions. Access to credit is very important in commercialization as this would help in expanding the business of the rural households when there is low or no income. Increase in credit received for commercialization could mean increase in income of rural households and a better livelihood and vice versa.

Table 3: Distribution of Respondents Based on access to credit, source of credit and amount received

	Credit parameters	Frequency n=156	percentage
1.	Poor access to credit		
	Yes	18	11.54
	No	138	88.46
2.	Source of credit		
	None	138	88.46
	Cooperative	07	4.49
	Bank	05	3.20
	Money Lender	06	3.85

3.	Amount of credit received		
	≤ 10,000	139	89.10
	10,001 – 50,000	3	1.92
	> 50, 0000	14	8.97
	Mean	17294.87	
	Minimum	0	
	Maximum	500000	

Source: Field survey 2018/2019

Table 3 reveals that majority of the respondents (88.5%) had no access to credit. Those that had (about 12%) sourced it from either cooperative, bank or money lender. Poor access to credit by farmers “has been noted as one of the major constraints militating against commercialization among farmers, particularly smallholder farmers”. (Lerman 2004, Martey et al. 2012). The table 3 further reveals that the mean credit received by the respondents was about ₦17,249.

4.2 Underutilized Edible Insects Commercialized.

There are over 1,600 edible insects but Table 4 shows the major edible insects commercialized in the study area. The edible insects available to the study area to a large extent determines the level of commercialization by rural households.

Table 4: Distribution of the major underutilized edible insects commercialized in the study area

Insects	Frequency n=156	Percentage
Cricket	47	30.13
Termite	70	44.87
Caterpillar	19	12.18
Grasshopper	8	5.13
Palm weevil	12	7.13

Table 4 shows that termite (44.87%) was the most abundant edible insect. This may be because their habitat is found not only in the forest but also in an open area like field. This is in relation to the work carried out by Agbidye et al (2019). Grasshopper emerged the least available edible insect (7.13%) in the study area.

4.2.1 Processing characteristics of Underutilized Edible Insects.

Table 5 shows the underutilized edible insects processing characteristics. Traditional processing methods are frequently used to increase the taste and sweetness of edible insects. A good processing method is a “factor in the commercialization of edible insects” for food and type of processing method to be used depend on the edible insects species.

Table 5: Underutilized edible insects processing characteristics

Method of processing	Frequency n=156	Percent age
Frying	116	74.5
Roasting	11	7.05
Sun drying	16	10.26
Boiling / frying	7	4.49
Boiling/ sun drying	6	3.85
Quantity harvested (kg)/ last harvesting season		
≤200	131	76.28
201-400	22	21.80
≥400	3	1.92
Mean	137.62	
Minimum	30	
Maximum	750	
Quantity processed (kg)/ last harvesting season		
≤100	106	69.95
101-200	35	22.43
≥200	15	9.62
Mean	115	
Minimum	15	
Maximum	700	

Hours of Processing/ week		
1-2	127	81.41
3-4	29	18.59
Total number of times of processing/week		
1	37	23.72
2	72	46.15
3	35	22.44
4	8	5.13
5	3	1.92
7	1	0.64
Types of trader		
Wholesaler	65	41.66
Retailer	45	28.85
Wholesaler & Retailer	46	29.49
Types of Market		
Farm gate	99	63.46
Village market	44	28.21
Urban market	13	8.33
Distance to nearest village market (km)		
≤2	81	51.92
2.1-5	51	32.69
≥5	24	15.39
Mean	3.27	
Minimum	1	
Maximum	27	
Net Income (₦/ last harvesting season)		
≤20,000	44	30.77
20,000- 50,000	68	43.49
≥50,0000	40	25.64
Mean	40,524	
Minimum	3200	
Maximum	273000	

Source: Field survey 2018/2019

Table 5 shows the underutilized edible insects processing characteristics. The table reveals that majority of the respondents (74.4%) used frying method as a means of processing their edible insects. Majority of the respondents (95.1%) harvested up to 400kg of underutilized edible insects and about 1.9% of the respondents harvested more than 400kg of edible insects. Furthermore, the result shows that about 67.7% of the respondents processed up to 100kg of the edible insects and 32.02% of the respondents processed more than 100kg of edible insects harvested.

Furthermore, the result shows that about 67.75% of the respondents processed up to 100kg of the edible insects and 32.02% of the respondents processed more than 100kg of edible insects.

Majority of the respondents (81.4%) used between 1-2 hours for processing of the edible insects and majority of the respondents (46.2%) processed edible insects two times per week. The table 5 further shows that majority of the respondents (69.9%) traded with the wholesalers in the last harvesting season and majority of the respondents (63.5%) sold their edible insects at farm gate. The mean distance of home to the nearest village market of the respondents as shown on table 5 was 3.27km

The result on Table 5 further shows that about 74.4% of the respondents generated up to ₦50,000.00 in the last production season and 25.6% generated above ₦50,000.00 with the mean income of ₦40,524.00.

4.3 Level of Household Commercialization of Edible Insects by Rural Households

Table 6 presents the distribution of households' commercialization into three categories; "High, medium and low-level commercialization".

Table 6: Level of Household Commercialization of Edible Insects

Classification	HCI	Frequency n=156	Percent age
Low commercialization 0 – 50		4	2.56
Medium commercialization 51 -70		25	16.03
High commercialization > 70		127	81.41
Mean		81.15	
Source: Computation from Field Survey 2018/2019			

Table 6 shows that majority of the respondents (81.4%) of the respondents were in the high commercialization index category while about 16.0% of the respondents were in the medium commercialization index category and about 2.6% were in the low commercialization index category.

4.3.1 Extent of Commercialization of Under-utilised edible insects of the last harvesting season in 2018.

The result of the commercialization of edible insects using household commercialization index to compile on table 7 shows that there is high commercialization of under-utilised edible insects in the study area. Palm weevil had 85.92%, this was followed by cricket having a ratio of 85.19%. Grasshopper emerged third with the ratio of 85.12% while termite and caterpillar were fourth and fifth respectively with a ratio of 81.89% and 81.60%. This implies there is a high level of awareness towards under-utilised edible insects in the study area

Table 7: Distribution of the extent of commercialization of under-utilised edible insects (UEI) in the study area

Under-utilised Edible insects	Mean UEI sales (kg)	Mean UEI harvested (kg)	Percentage ratio
Cricket	138	162	85.19
Termite	104	127	81.89
Caterpillar	102	125	81.60
Grasshopper	103	121	85.12

Palm Weevil	122	142	85.92
Source: Computation from Field Survey 2018/2019			

4.4 Determinants of Commercialization

Table 8 presents the Tobit result of the factors affecting the level of commercialization of Under-utilised Edible Insects (UEI). These determinants as shown on table 8 are sex, marital status, years of schooling, Income and household size. All these characteristics were regressed against Commercialization index.

Table 8: Factors Affecting the Level of Commercialization of Underutilized Edible Insects

Determinants of Commercialization

Variables	Coefficient	Standard error	t-value	P > t value
Gender	0.0729556*	0.0394412	1.85	0.066
Marital Status	0.1236073**	0.0609383	2.03	0.044
Mem. In Association	0.0079101	0.0367898	0.21	1.830
Years of schooling of household head	-0.1006691*	0.0510977	-1.97	0.051
Primary Occupation	-0.0093818	0.0351817	-0.27	0.790
Income (₦)	6.931052***	1.1960400	5.79	0.000
HH Size	-0.8339372***	0.0360950	-23.10	0.000
Total Land owned (Ha)	2.01e-07	0.0293811	0.00	1.000
Distance of home to nearest village market (Km)	0.0091409	0.0153193	0.60	0.552
Constant	0.1250487	0.2047250	0.61	0.542
Source: Field Survey 2018/2019				

*, **, *** indicates p-values significant at 10%, 5% and 1% respectively. The table presents the determinant of commercialization

Table 8 presents the determinants of commercialization. Gender was found to positively and significantly influenced commercialization at 10%. This implies that male headed households were more involved in commercialization than female headed households. Involvement of

female in commercialization of edible insects tends to decrease due to increasing household chores and child bearing. Marital status was found to be significant at 5% level and positively influenced commercialization. This implies that married people were more involved in commercialization of edible insects than the singles. This may be due to the financial responsibility that married people are saddled with at home, so they need to engage on something extra that can help meet their financial needs. This result is in line with the study carried out by Hlongwane, Ledwaba and Belete (2014). Years of schooling of the respondents was also found to be significant but negatively influenced commercialization of edible insects. This implies that as educational level of respondents increases, they tend to migrate from the rural areas to urban areas in search of greener pasture. Therefore, as educational level of the respondents' increases, commercialization decreases. This is related to the work carried out by Martey (2014), Gani et al (2011), Adenegan et al (2012), Adenegan et al (2013), Adeoti et al (2014). Household income was found to positively and significantly influence commercialization and the result is significant at 1% level. A unit change in income of rural households would bring about expansion in business and thus better standard of living. This implies that an increase in income of the rural households will result to an increase in the probability of commercialization among them. This is related to the study carried out by Agwu, Anyanwu and Mendie (2012) and Argu and Ibenbuchi (2011) had "opined that income leads to increase in volume or quantity traded and expansion of enterprises".

Household size was also found to be significant at 1% but negatively influenced commercialization. This implies that large families sell less as compare to small families due to their greater consumption needs. Therefore, as family members increase, commercialization decreases. This agrees with the work carried out by Agwu (2012), Gebremedhin and Jaleta (2010a) and Enete and Igbokwe (2009). And according to these researchers, "large household

sizes reduces households from commercialization due to its effect on the increasing household domestic consumption needs”.

4.5 Classification of Household Livelihood Security of Respondents

Table 9 presents the household livelihood security index of respondents by classifying them into two: High and Low livelihood. The respondents were classified using HLSI average which was 0.27. Respondents below this average were classified to have low livelihood and above this average were classified to have high livelihood.

Table 9: Household livelihood security index of respondents

Classification	HLSI	Frequency n=156	Percentage
Low livelihood status	0.1165121 – 0.268153	86	55.13
High livelihood status	> 0.2681537	70	44.87

Source: Field survey 2018/2019

The result on Table 9 shows that about 55.13% of the respondents have high livelihood and about 44.87% of them have low livelihood.

4.6 Marketing margin of Under-utilised Edible insects

Table 10 presents the marketing margin of each of the edible insects available to the study area in the last harvesting season. These edible insects are Cricket, Termite, Caterpillar, Grasshopper and Palm weevil.

Table 10: Returns to UEI Commercialization using Marketing Margin/Household in the Last Harvesting Season

Insects	Sales Price (₦)	Cost Price (₦)	Marketing Margin (₦)
Cricket	47,931	976	46,955
Termite	41,106	807	40,299
Caterpillar	40,461	853	39,608
Grasshopper	42,063	888	41,175
Palm weevil	44,917	1425	43,492

Source: Field survey 2018/2019

The result on table 10 shows that the marketing margin of the edible insects was high. The households were able to generate reasonable profit from the sales of the underutilized edible insects. Crickets had the highest profit (₦46,955).

4.7 Contribution of Edible Insects' Commercialization on the Livelihood Status of Respondents.

Table 11 shows the OLS result of the contribution of commercialization of edible insects to the livelihood status of respondents. Variables like primary occupation, distance to nearest village market, amount of credit received, and household commercialization index were found to be significant.

Table 11 CONTRIBUTION OF COMMERCIALIZATION TO THE LIVELIHOOD STATUS OF THE RESPONDENTS

	Coefficient	Standard error	t-value	P > t value
Gender	0.0030594	0.0046467	0.66	0.511
Primary Occupation of household head	-0.0071398*	0.0041320	-1.73	0.086
Ln years of Processing	-0.0006798	0.0035216	-0.19	0.847
Ln Distance of home to nearest village market	-0.00387446**	0.0017678	-2.19	0.030

Ln total Land Owned	0.0053691	0.0033201	1.62	0.108
Ln Amount of credit Received	0.0010941**	0.0005454	2.01	0.047
Ln Number of Extension Contacts	-0.0100371	0.0079908	-1.26	0.211
Ln Household Commercialization index	0.068392***	0.0043668	15.66	0.000
Constant	0.184823	0.0097602	18.94	0.000

Source: Field survey 2018/2019

*, **, *** indicates p-values significant at 10%, 5% and 1% respectively.

On Table 11, Primary occupation of household head was found to be significant at 10% but negatively influenced livelihood. This implies that respondents whose primary occupation is farming have better livelihood status than those that are not practicing farming. Farming households with a larger family size have an advantage of having family labour thus enhancing their commercialization activity and this will bring about an improvement on their livelihood status. Distance of home to the nearest village market was significant at 5% but negatively influenced livelihood. A market that is far away from the farmers will bring about decrease in respondent's livelihood. Amount of credit received was also found to be positive and significant at 5%. Good access to credit can help households expand their business thus generate more income that would make their livelihood better off. This implies that as farmers receive additional money, their livelihood will also increase. Household Commercialization Index which was the main variable was also found to be significant at 1% and positively influenced livelihood. Surpluses taken to the market by the respondents generate extra cash which households can use to procure other things they need in the household thus having better livelihood. This implies that as commercialization increases, livelihood also increases.

CHAPTER FIVE

5.0 SUMMARY OF MAJOR FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

Consumption of edible insects is not a new concept. Edible insects have been consumed by many people in Africa, Nigeria inclusive particularly in the rural areas where they see them as part of their delicacy.

Insects harvesting and commercialization require a little to no capital investment opportunity that provides entry to both the women and the landless. Edible insects can also offer livelihood opportunity for people around the world.

This study therefore examined the commercialization of under-utilised edible insects in Benue state. Survey data was employed by the study. Ordinary Least Square and Tobit Regression were the economic tools used for the data analysis. Other tools used included Household Commercialization Index (HCI), Marketing margin and Descriptive Statistics.

The Descriptive Statistics revealed the mean age of the respondents to be 43 years. Majority of the sampled respondents for this study were male (73.7%) and majority were also married (79.5%). 45% of the respondents belonged to one association or the other while about 55% did not. The mean household size was found to be 5.5. The respondents (33.9%) also had contact with extension agents. Majority of the respondents (33%) had secondary school education and this implies the respondents could read and write. 46% of the surveyed respondents had farming as their major occupation. The mean farm size was 2.9ha and the mean years of processing was 12 years.

The distribution of respondents based on access to credit, source of credit and amount received revealed that majority of the respondents (88.5%) had no access to credit. Furthermore, majority of the respondents (89.1%) collected less than ₦10,000 from financial institutions in the last harvesting season.

In addition, the major edible insects available to the study area are cricket, termite, caterpillar, grasshopper, and palm weevil. Termites (44.9%) being the most abundant edible insects in the study area. Majority of the respondents (74.4%) in the study area processed their edible insects using frying method. The quantity of edible insects harvested in the last harvesting season on the average was 137kg while the quantity processed on the average was 115kg. Majority of the respondents (81.4%) processed their edible insects between 1-2 hours per week and 46% of the respondents processed edible insects two times per week. Furthermore, majority of the respondents (69.9%) traded with the wholesalers in the last harvesting season and majority of the respondents (63.5%) also sold their edible insects at farm gate. The mean distance to the nearest market of the respondents was 3.27km

The mean income generated from the sales of the edible insects was ₦40,524.00. The study further revealed that there is high commercialization of edible insects in the study area. The level of household commercialization of the edible insects using HCI revealed that about 81.41% of the respondents were in the high commercialization index category while about 2.56% were in the low commercialization index category. The distribution of the extent of commercialization of underutilized edible insects in the study area revealed that palm weevil had the highest commercialization ratio.

The determinant of commercialization using Tobit regression model to analyze revealed that sex, marital status, years of schooling, household size and income were the significant

variable. Sex and marital status were found to be positive and significantly influenced commercialization. Years of schooling, household size and income were significant but negatively influenced commercialization. The livelihood status of the rural households that were estimated using HLSI average revealed that 55% of the respondents had low livelihood status.

The study further revealed that the rural households made reasonable profit from the sales of edible insects as revealed by marketing margin.

Conclusively, the result of OLS revealed the contribution of commercialization of under-utilised edible insects to the livelihood status of the respondents. Commercialization was found to be positive and significant at 1%.). Commercialisation of under-utilised edible insects significantly enhanced the livelihood status of the rural households ($R^2 = 67.4\%$). Other significant variables were primary occupation, distance of home to the nearest village market (km), and amount of credit received.

5.2 CONCLUSION

Insects are not only consumed in times of hunger. They are part of the local diets of those that consume them and are consumed majorly because of their taste. These insects are used as human food, animal feed as well as for experiments. They are also a source of income which can support livelihood as seen in the study. Based on the findings of this study, it can be concluded that commercialization of edible insects has positive impact and significantly contribute to the livelihood status of the respondents.

5.3 RECOMMENDATIONS

Given the results obtained for this study, the following are therefore recommended.

1. The farmers should encourage themselves by commercializing more of these under-utilised edible insects as this will improve their livelihood.
2. More land should be opened for agriculture in the rural area so that respondents can have more land for farming activities.
3. Credit facilities should be made available to rural households for the expansion of business. Rural households should try to join cooperative societies in their community so that they can save and also have access to credit.
4. Rural households should look into the sustainability of these insects. Insects are becoming hard to get as their environments are being demolished at a disturbing rate. They should therefore encourage themselves to start farming edible insects as mini livestock as this will make edible insects to be commercialized in large scale.
5. They should also try to provide themselves with necessary market infrastructures that will facilitate commercialization of edible insects.

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UNIVERSITY OF ILORIN, ILORIN
DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

**COMMERCIALIZATION OF EDIBLE INSECTS AMONG RURAL HOUSEHOLDS
IN BENUE STATE, NIGERIA.**

QUESTIONNAIRE

Dear respondent, this questionnaire is designed to obtain information on edible insects. Information obtained will be strictly treated with confidentiality and will be used for research purposes. Thank you.

A. SURVEY IDENTIFICATION

Questionnaire ID: Interview Date

Enumerators Name:

State: LGA: Village:

B. HOUSEHOLD IDENTIFICATION

Age:..... Ethnicity:.....

Religion: Christianity (_) | Islamic (_) | Traditional (_)

Marital Status of Respondent: Single (_) | Married (_) | Divorced (_) | Widow(er) (_)

Status in the Household: Head () Spouse ()

Educational level: Quranic Education (_) Primary Education (_) Secondary Education (_)

Tertiary Education (_) Adult Education (_)

C. HOUSEHOLD COMPOSITION

Please report the household composition. Please note: A “**household**” includes all members of a common decision-making unit (usually within one residence) that are sharing the same household resources. These include dependents that are away from home.

a. How many of your children are below the 15 years of age? _____

PID	Names of household member who is above 15yrs	Age	Relationship to household head e.g. head, spouse, child, siblings, other family members	Gender Male=1 Female=2	Level of education e.g. quranic, pry, sec, tert, adult edu.	Primary activity e.g. Farming, teaching, trading etc.

PID Personal Identification Number*

D. PRODUCTIVE ASSETS ACQUISITION

Productive assets e.g. cutlass,	Type of ownership (hhhead or association, rentage)	Total number of assets	Problems encountered using these assets e.g. poor quality, tear and wear
1.			
2.			
3.			

E. EDIBLE INSECTS PROCESSING OUTPUT

What insects do you process?	Method of processing	When did you start processing?	Total number of hours used in processing this insect per day	How many times do you process in a week?	Total quantity of raw insects processed	Unit (e.g kg, bag, tin)	Price of processed insects	Daily wage rate (₦)
1.								
2.								
3.								
4.								
5.								

F. INSECT MARKETING

Edible insects	Total quantity processed	Units	Quantity consumed by household (unit)	Quantity sold (Naira per unit)	Farm gate price (Naira per unit)	Marketing method
1.						
2.						
3.						
4.						
5.						

G. ACCESS TO MARKETING INFRASTRUCTURE

Report your current access to roads and cost of transportation

1.	Distance to nearest town (km (over 20,000 people)	
2.	Distance to nearest market (km)	
3.	Time taken to wait for motor vehicle transport to market (minutes) ¹	
4.	Time taken to wait for motorcycle transport to market (minutes) ¹	
5.	Fare to nearest urban area by motor vehicle to market (Naira/passenger)	
6.	Main means of transport to nearest market ²	
7.	Travel time by motor vehicle to all-weather road (minutes) ¹	
8.	Distance to nearest all-weather road (km)	
9.	Three most important types of traders you do business with? 1=assembler,	
10.	Three most important types of markets where you sell? 1=farm gate, 2=village market,	

H. CLIMATE INFORMATION

1. How do you consider the climatic conditions (rainfall) during 2017 -18 cropping year?

(a) Good (b). Normal (c). Bad (d). Very bad

2. What is your opinion about rainfall pattern during 2017-18 farming year?

Characteristics		Observations
1.	Oftenness of rainfall	
2.	Number of rainy days	
3.	Availability of water resources	
4.	Temperature (Hot/extremely hot/hotter)	

3. What quantity of insects did you harvest in the last rainy season?

Name of Insects		Quantity
1.		
2.		
3.		
4.		
5.		

I. MEMBERSHIP IN ASSOCIATIONS/GROUPS

Do you belong to any group/association? ____ 1=Yes, 2=No.

(If yes, complete the following table. If No, move to Item J)

1. Type of Group	2. Are you a member? Yes=1, No = 2	3. Person id(s) of your household member(s) who belong to this group	4. Specific Name of group	Code	5. Degree of participation ¹	6. What benefit do you get from the group?
Cooperatives						
Religious association						
Mutual support group (e.g., age group, women's group)						
PTA (Parent Teacher association)						
Others (specify)						

J. HOUSEHOLD ASSETS (excluding livestock & productive assets mentioned above)

1. Land access & holding (hectares) in the last 12 months

	1. Area irrigated	2. Rainfed area	3. Land under non-agricultural uses
1. Total land owned (ha)			

2. Total Value of the land owned (Naira)			
3. Total land rented in (ha)			
4. Total land rented out (ha)			
5. Rental rate (Naira/ha per season)			
6. Total land sharecropped in (ha)			
7. Total land borrowed in (ha)			
8. Total land sharecropped out (ha)			
9. Total land lent out (ha)			
10. Total land under cultivation (ha)			

K. NON- PRODUCTIVE ASSET

Number and value of household non-productive assets. (NB Value is seeking for the estimated value of the assets in their prevailing state as at time of the survey.)

	Number	Present Value (Naira)
1. House (main house)		
2. Others buildings (i.e. others huts, kitchen)		
3. Furniture		
4. Furnishings e.g. mat, mattress		
5. Household Appliances e.g. Kettle, iron, etc.		
6. Electronic Equipment e.g., Radio, Cassette, Mobile phone, TV		
7. Non-commercial vehicle (e.g. saloon car)		
8. Satellite dishes		
9. Others household assets		

L. ACCESS TO CREDIT

1. Have you received any form of credit in the past five years? **Yes**=1, **No** = 2 _____

2. If **Yes**, report the source of credit and the year(s) received. If **No**, move to item **M**

1. Source of credit ¹	2. Household member(s) who borrowed	3. Amount received (Naira)	4. Interest rate	5. Non-Interest cost	6. Purpose of borrowing
1.					
2.					
3.					
4.					
5.					

M. ACCESS TO USE OF AGRICULTURAL RESEARCH AND EXTENSION SERVICES

Type of Technology /production activities	Provider of research or Extension service	Effectiveness of research	Usefulness of research	Did you adopt the technology ?

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N. HOUSEHOLD INCOME AND EXPENDITURE

- What is your average total household income: _____
(a) Weekly _____ (b) Monthly _____ (c) Annually _____

Please fill the Table below as appropriate

Source of income	Annual income (Naira)	% in Proportion
(a) Edible Insects		
(b) Other crops		
(c) Non-farm activities		
(d) Other household members		
(e) Remittances		
(f) Total		

- What is your overall monthly expenditure on the average? _____

Please fill the Table below as appropriate

Items of Expenditure	Amount spent monthly (Naira)	% in Proportion
(a) Food expenses		
(b) Health related expenses		
(c) Non-food expenses		
(d) Savings		
(e) Total		

- What is the total value of your household assets? _____

Asset category	Total value in Naira
(a) Household gadgets	
(b) Farm implements and machines	
(c) Building	
(d) Farm land	
(e) Animals and Livestock	
(f) Shares, stocks and liquid cash	
(g) Others	

O. EDUCATION AND EMPOWERMENT SECURITY

- What is your highest educational qualification in years of schooling? _____
- Please complete the following:
 - Number of literate household member _____
 - Number of literate adult male (>15years) _____
 - Number of literate adult female (>15years) _____
 - Number of 6 – 10years children enrolled in school _____
 - Number of >10years children enrolled in school _____
- Do you belong to any community society? Yes (i) No (ii)
 - If yes, how many? _____
- Do any other household member belong to community society? Yes (i) No (ii)
 - If yes, how many household members? _____

5. Do you hold any executive post in your society? Yes (i) No (ii)
6. Do any of your household member hold executive post? Yes (i) No (ii):

P. FOOD SECURITY

- How much do you spend on feeding in a month on the average? _____
- How many times do you eat on the average per day? _____
- What food did you eat yesterday? _____
- Was yesterday a normal feeding day? Yes (i) No (ii)
- In the last 12 months, have you been faced with a situation anytime, where you do not have enough food to feed your household? Yes (i) No (ii)

Please fill the Table below as appropriate.

Please tick and state the quantity of any of the under listed food items consumed in your household in the last 24 hours.

24-hour food recall (Note: If the food item is consumed = 1, and if not = 0)

S/N	Food Group	Examples	Yes= 1 No = 0	Quantity (Kg, muddle, tin, cup)	Source of Food: 1= Own production, hunting, fishing 2= Purchased 3= Borrowed, exchanged for labour, gift from friends or relatives 4= Food aid 5= Other
1	CEREALS	corn/ maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products)			
2	WHITE ROOTS AND TUBERS	white potatoes, white yam, white cassava, or other foods made from roots			
3	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrot, squash, or sweet potato that are orange inside + <i>other locally available vitamin A rich vegetables (e.g. red sweet pepper)</i>			
4	DARK GREEN LEAFY VEGETABLES	dark green leafy vegetables, including wild forms + <i>locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach</i>			
5	OTHER VEGETABLES	other vegetables (e.g. tomato, onion, eggplant) + <i>other veg.</i>			
6	VITAMIN A RICH FRUITS	ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + <i>other locally available vitamin A rich fruits</i>			
7	OTHER FRUITS	other fruits, including wild fruits and 100% fruit juice made from these			

8	ORGAN MEAT	liver, kidney, heart or other organ meats or blood-based foods			
9	FLESH MEATS	beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects			
10	EGGS	eggs from chicken, duck, guinea fowl or any other egg			
11	FISH AND SEAFOOD	fresh or dried fish or shellfish			
12	LEGUMES, NUTS AND SEEDS	dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. hummus, peanut butter)			
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products			
14	OILS AND FATS	oil, fats or butter added to food or used for cooking			
15	SWEETS & BISCUITS	sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes			
16	Spices, Condiments, beverages	spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic Beverages			
17	Food consumed away from home	Did you or anyone in your household eat anything (meal or Snack) OUTSIDE the home yesterday?			

Q. HEALTH SECURITY

- How many days do you visit hospital or health centre in a month on the average? _____
- Where do you visit when you have health problem?
Traditional healers (i) Community health center (ii) Private health centre (iii) Teaching Hospital (iv) Other (v), Specify _____
- How much do you spend on health-related issues in a month on the average? _____
- How many days of work do you miss due to illness in a month on the average? _____

BUDGET FOR THE STUDY

S/N	Activities	Break-down	Quantity	Unit cost (₦)	Total cost (₦)
	Total school fee and registration	Four years school fees, acceptance and Student Union charges			650,000
1	Search and Review of Literature	Assessing the internet Assessing Library (State, Federal, University etc) Printing Photocopies	42 months 42 months	5,000/mth 5,000/mth	100,000 100,000 30,000 25,000
2	Preliminary field investigation	Visit to State capital market, Makurdi			50,000
3	Writing Proposal	Printing			20,000
4	In- house and Pre-field Seminar	Printing	37 copies	1,000/copy	37,000
5	Ethical approval	Printing	3 copies	1500/copy	4,500
6	Protocol writing	Printing	5 copies	2,000/copy	10,000
7	Data Collection	Training of enumerators (allowances) Pretest Questionnaire Retest Questionnaire Printing of Questionnaire Hotel Accommodation/Feeding/Transport fare Paying Enumerators	6 persons 400 copies 15 days	4000 40/copy 3,500	24,000 30,000 30,000 16,000 52,500 500,000
8	Data Analysis	Data collation/processing Analyzing data			50,000
9	Post-field Seminar	Printing and Soft Binding	35 copies	1,000/copy	35,000
10	Defense	Printing and Soft Binding	10 copies	1,000/copy	10,000
11	Final Printing and Binding	Printing and Binding	6 copies	2,500/copy	15,000
12	Miscellaneous				20,000
	TOTAL				1,709,000

Source: Researcher's Design, 2018

Source of Funding

The project will require a sum of 1,709,000 only. The project will be funded with personal savings and grants. To this end, grants shall be sought from local and international organizations to aid the research work.